AN OGDEN PUBLICATION DEVOTED TO GLASS TECHNOLOGY, ENGINEERING, MATERIALS AND GLASS FACTORY EQUIPMENT AND OPERATION

the glass industry

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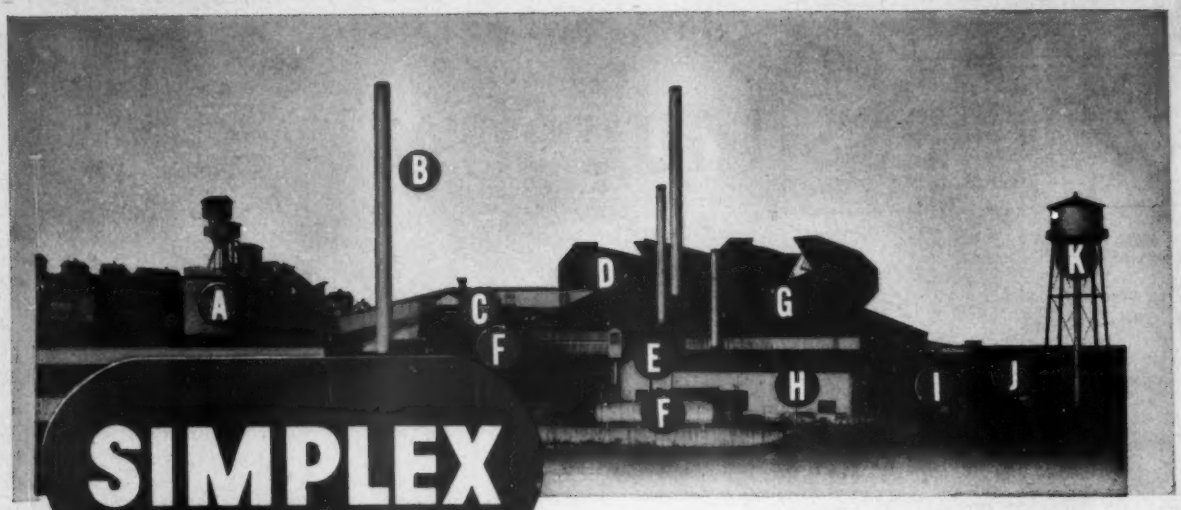

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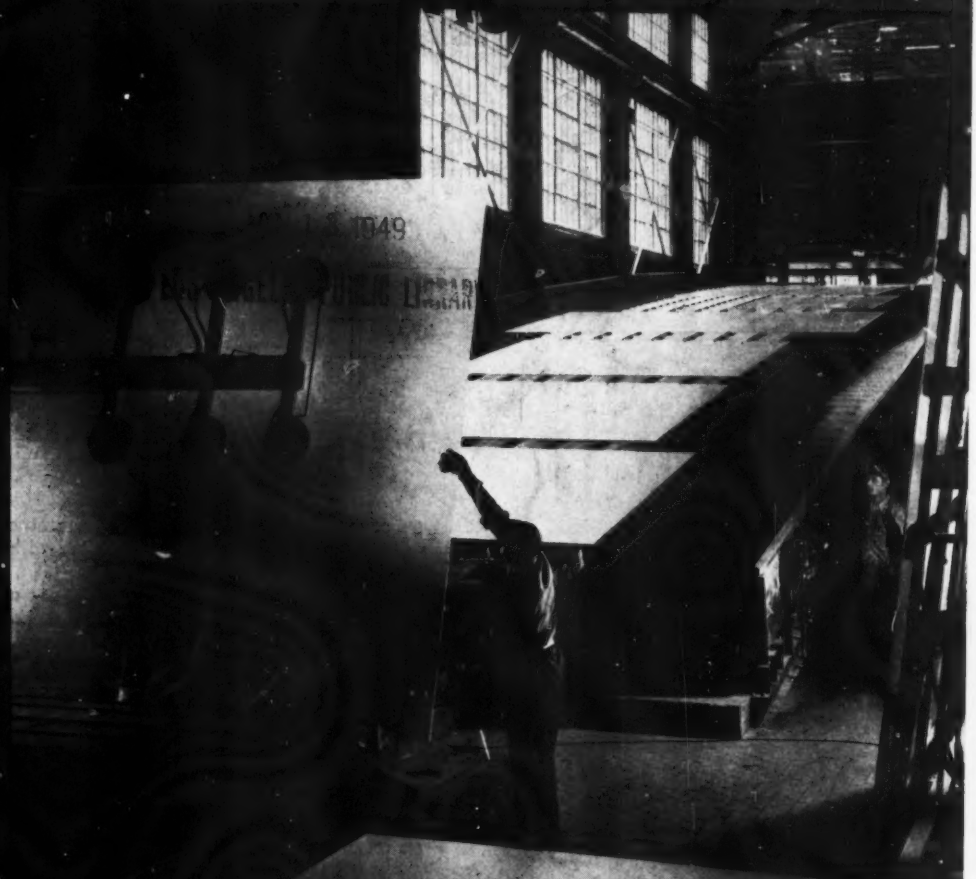

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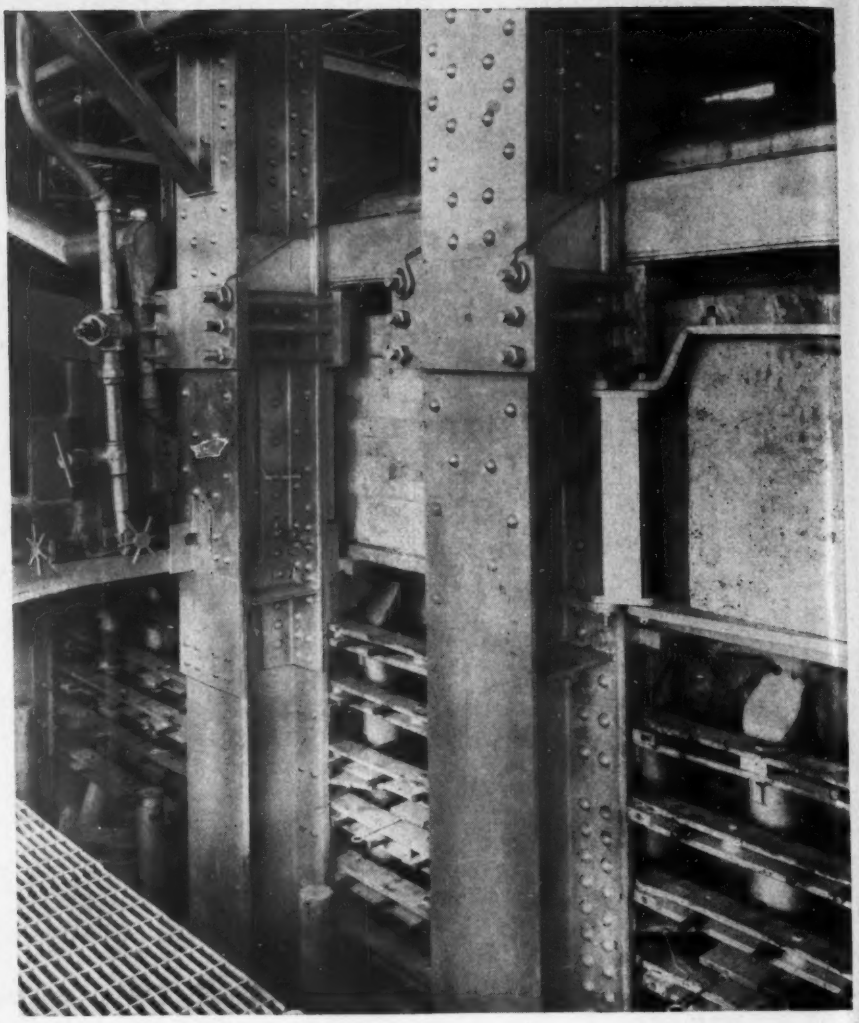

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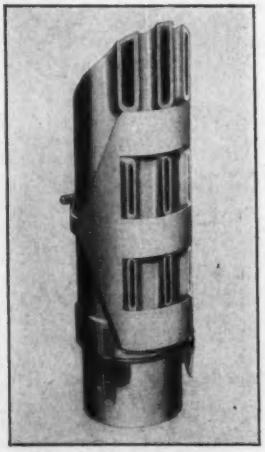

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THE GLASS INDUSTRY

VOLUME 30, NUMBER 1, JANUARY, 1949

AN EMPIRICAL TREATMENT OF VISCOSITY DATA AND ITS APPLICATION TO QUALITY CONTROL IN THE GLASS INDUSTRY

By JAMES P. POOLE

Pennsylvania State College, State College, Pa.

Introduction

Several years ago, a problem arose concerning the rapid determination of viscosity and the application of such data to quality control in a glass container plant. The techniques which were developed as a result of this study make it possible to determine the viscosity characteristics of a container glass from the melting through the annealing range of temperature by making only one experimental measurement. This method has been in constant use for more than two years and has proven itself to be a valuable contribution to good quality control.

The equipment and methods used for making absolute determination of viscosity by the fiber elongation method have been described in detail in another paper.[1] Data, which are precise to within $\pm$ 1%, can be obtained from this apparatus in the viscosity range of from 10^7 to 10^{15} poises.

Treatment of Data

In the conventional treatment of viscosity temperature data, the logarithm of viscosity ($\log \eta$) is plotted against the reciprocal of the absolute temperature $\left(\frac{1}{T}\right)$.

Unfortunately, this does not produce a straight line relationship between viscosity and temperature except through rather narrow limits. Thus, it is impossible to extrapolate low-viscosity values from high-viscosity data. If experimental data are obtained throughout the temperature range corresponding to $\log \eta = 2$ to $\log \eta = 15$, the Fulcher[2] equation can be used to represent the data to within $\pm$ .5%. This, however, is a tedious and lengthy process; several types of measuring equipment must be used to cover this wide range of viscosity, and the determination of the three constants involved requires a calculation of least squares.

Various techniques of plotting viscosity-temperature data were tried with the hope of finding a faster and easier method. This study has resulted in the construction of arc hyperbolic sine graph paper with the aid of tabulated values of the arc hyperbolic sine ($\sinh^{-1}$) function from 0-15. The hyperbolic sine is defined by the relation $\sinh x = \frac{1}{2}(e^x - e^{-x})$. Values of this function are readily availabble in a number of published tables.

Figure 1 shows a sheet of this graph paper which has been reduced from 24" x 18" for reproduction here. A marked similarity to semi-log paper can be observed, as when the value of the argument is greater than three, the hyperbolic sine is the exponential function. For values less than unity, the hyperbolic sine is linear.

It is here that the advantage of this type of graph paper comes in as it makes possible an approximate logarithmic plot, yet having a zero origin. As $\log \eta$ values are plotted along the $\sinh^{-1}$ ordinate, it can be seen that the plot of the $\sinh^{-1} \log \eta$ vs. $\frac{1}{T}$ is approximately the same as $\log \eta$ vs. $\frac{1}{T}$, except that there is a zero origin.

If experimental viscosity-temperature data are plotted on this paper, as on Figure 1, a straight line passes through all the points and the origin. The data used for this plot are those for Glass 10 from Robinson and Peterson's work.[3] This curve is typical for average compositions of soda-lime-alumina-silica container glasses. Much other reliable viscosity data[4, 5, 6] have been plotted in this fashion with excellent results. In some glasses, especially those having high amounts of magnesium or barium, there is a tendency for the points to fall to the left of the straight line in the range of

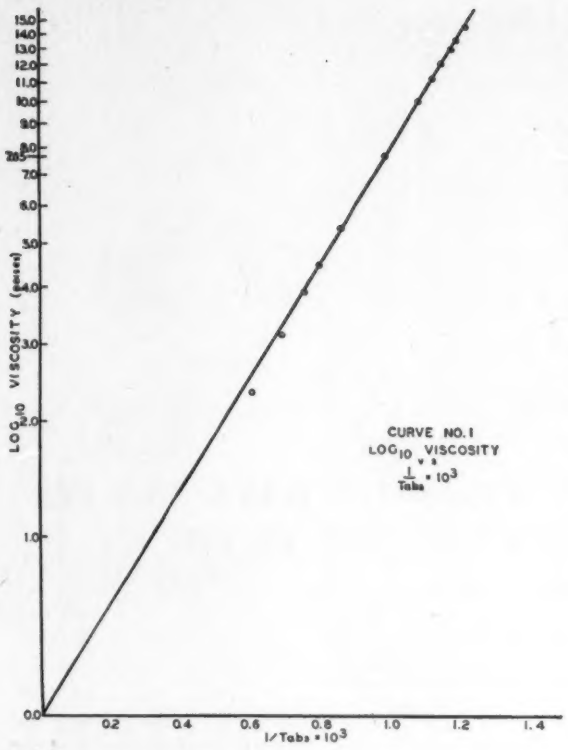


Fig. 1.

log η 4 to log η 8. However, above and below this range, the fit is usually excellent.

This technique will not work for high borate, borosilicate, or lead glasses but seems to be limited to silicate glasses of normal composition.

Technique for Rapid Alterations of Viscosity Characteristics

The fact that a plot of $\sinh^{-1}$ log η vs. $\frac{1}{T}$ results in a straight line through the origin immediately suggests a method for a rapid determination of the complete viscosity-temperature behavior of a glass.

The normal procedure in this laboratory, in which three constant temperature fiber furnaces are available, is to make at least two viscosity measurements about 20°C. apart. These data are plotted on the $\sinh^{-1}$ paper and a straight line is drawn through these points and the origin. Obviously only one point need be used. The other is merely for a check. In the past, it has been found that if the experimental points do not lie on a straight line through the origin, a mistake has been made in the calculation, the measurement is in error, or the thermocouples need recalibration. The latter is easy to detect as this error increases with time and can be checked by running a standard glass periodically. For the Pt.-Pt. 10% Rh. couples used, it has been found necessary to calibrate them about every three months to avoid this error. A misplot generally is corrected by a repeat run.

Any viscosity values within the normal range of the equipment can be used for this determination but it has been found most convenient to use values of about 10^{10} and 10^{11} poises for the two measurements as the time for equilibrium and the experimental run are quite short.

Calculation of Results

After the data have been obtained and the curve has been plotted* satisfactorily, an intercept of this curve is determined with the $\frac{1}{T}$ axis by reading from the steel scale with the hand glass. Although the various temperatures for viscosity check points can be read directly from the curve, results are more consistent if they are calculated since the equation of the line is known, and the slope can be established from experimental data. A set of typical calculations follows:

Let us calculate the temperature at which the log η of the glass is 7.65. This corresponds to the softening temperature as defined by Littleton.[7] The equation of the curve is:

$$\sinh^{-1} \log \eta = \frac{1}{T_a} \times 10^3 \qquad (1)$$

$$\text{where: } m = \text{slope} = \frac{\text{x value of sinh x}}{\frac{1}{T_a} \times 10^3} \qquad (2)$$

Assume the curve crosses the $\frac{1}{T}$ ordinate at 1.200 at 13.00 log η. Therefore, the sinh x is 13.00. The x value is then 3.26**. This is done to convert the arc hyperbolic scale to the linear scale with which the paper was constructed.

$$\text{therefore: } m = \frac{3.26}{1.200} = 2.72 \qquad (3)$$

To find the temperature at which log η = 7.65, convert $\sinh^{-1}$ log η 7.65 to the linear value which is 2.732. Then as:

$$\sinh^{-1} \log \eta = m \frac{1}{T} \text{ or } \frac{2.732}{2.72} = \frac{1}{T_a} \times 10^3 = 1.008 \qquad (4)$$

$$\frac{1}{1.008} \times 10^3 - 273 = 719°\text{C.} \qquad (5)$$

All constants for these calculations can be calculated and tabulated for greater ease of manipulation. A special slide rule has been designed which greatly speeds up calculation of the results.

It has been the custom in this laboratory to calculate in this manner and report the gob temperature, log η = 3; softening temperature, log η = 7.65; annealing temperature, log η = 13.4; and the strain temperature, log η = 14.6 for control checks. After receipt of the fibers for measurement, only about ten minutes are required for the complete experimental determination and calculation of these reference points.

Precision

A detailed discussion of the precision of the experimentally determined viscosities is given in the paper[1]

(*Continued on page* 56)

* Reciprocal temperature points are plotted with the aid of a hand glass for increased accuracy from a steel rule calibrated in $\frac{1}{100}$". Viscosity points are plotted directly from the $\sinh^{-1}$ log η ordinate.

** This comes from the fundamental equation of $\sinh x = \frac{e^{x} - e^{-x}}{2}$. Solving for x gives the linear equivalent of the sinh x.

TENTH GLASS CONFERENCE

Instrumentation, refractories and decorating form the subject matter of papers given at the first joint Conference at Columbus.

The Tenth Conference on Glass Problems, under the auspices of Ohio State University and the University of Illinois, was held December 2 and 3, 1948, at the Deshler-Wallick Hotel, Columbus, Ohio. This is the first conference which has been held under the new joint auspices at the Ohio State University. All previous conferences have been held at the University of Illinois. Owing to the crowded conditions at Ohio State University, it was necessary to hold the Conference meetings at the hotel; excellent facilities were provided by the hotel and the meeting was convenient for all those who were in attendance. This Tenth Glass Conference dealt with instrumentation, refractories and glass decoration. Professor Henry Blau, of the Ohio State University, stressed the desirability of audience participation and discussion at the Conference. This theme was evident throughout the meeting, inasmuch as this has been one of the key factors in the success of the Conference in the past, and it is desirable in spite of the increased attendance to continue to obtain maximum discussion from the attending visitors. These conferences are intended primarily for the operating man and are meant to provide the means of exchanging ideas and results which are obtained or which might be helpful in the operation of glass plants.

Messrs. J. R. Green, of the Brown Instrument Company, and J. C. Peters, of Leeds and Northrup Company, presented papers on instrumentation and automatic control equipment applicable to the glass industry. Dr. Harry H. Holscher, as Chairman of the opening morning session, pointed out how little was known, for example, of the actual temperature distribution within the inside of a glass furnace. Although the problem of accurately measuring conditions within a furnace at glass-melting temperatures is a difficult one, great strides have been made. Mr. Green illustrated the various conditions within a glass furnace which are capable of instrumentation and showed diagrams of complete automatic control systems. Although representing Brown Instrument, Mr. Green endeavored to give an impartial presentation, and uniquely indicated when he was giving a "sales pitch."

In his talk, Mr. J. C. Peters dealt primarily with the fundamentals of gas- or oil-firing combustion controls and their application to glass tanks. Mr. R. J. McKinstrey, of Anchor Hocking Glass Co., gave a very interesting presentation on the use of automatic combustion controls from the operators' viewpoint.

Professor Faye Tooley, of the University of Illinois, was toastmaster of the banquet which was held on December 2nd. He introduced the various dignitaries who were seated at the table, and the speaker of the evening, Dr. R. M. Schaffert, of Battelle Memorial Institute, who spoke on "Xerography." Dr. Schaffert presented a new, dry method of graphic reproduction which has interesting possibilities. The precise and showmanlike quality of the presentation was of extreme interest. Xeroprinting was demonstrated also, and it was fascinating to see this rapid printing without the use of the customary type ink rolls, etc. Samples from the xeroprinting machine were taken by many people as souvenirs. This unique method of reproduction, based on the utilization of electric charges, appears to be a field which will bear watching. Of interest to the glass men was the possible use of this unique method in the decorating of glass. Specimens were shown of glass and ceramic articles which were decorated by this process, indicating that a new field of development exists in the application of color to glass and ceramics. Excellent demonstrations of work that had been done on paper showed that this method has wide applications.

The Friday session was devoted to refractories and to decorating. The refractory session consisted of papers by Messrs. R. W. Knauft, of the Chas. Taylor Sons Company, W. F. Rochow, of Harbison-Walker Refractories Company, and R. G. Abbey, of the General Refractories Company. Mr. Knauft discussed the broad field of special refractories; he presented many excellent slides of case histories taken from actual installations which demonstrated the incompatibilities of some of the refractories in the glass furnace. The use of sillimanite, zircon and other refractories was discussed. Mr. Rochow's discussion was limited more or less to the basic-type refractories, such as the chrome-magnesite or the magnesite-chrome in checker applications. His presentation was short and to the point. Mr. Abbey gave an excellent presentation covering the use of basic refractories in checker applications and apparently had the subject well in hand based on his intimate experience. Abbey stated that the use of high-alumina refractories in combination with basic bricks in a checker was not so

Left to right: H. H. Blau, University of Illinois, F. V. Tooley, University of Illinois, J. L. Carruthers, Ohio State University.

Left to right: J. W. Whittemore, The American Ceramic Society, H. M. Kraner, The American Ceramic Society, A. K. Lyle, The American Ceramic Society and C. S. Pearce, The American Ceramic Socity.

good as the use of lower alumina brick, such as a clay brick, owing to the more viscous slag formed. He felt that this was an important consideration and very pointedly indicated that sillimanite brick should not be used in combination with the basic brick. It was of interest to note that he indicated that although the basic brick had little or no strength after use in a checker, they still were suitable for use in the checker work without replacement. He cited one case where the bricks were so weak that they had to be carefully removed on a pallet to the laboratory, but still the entire checker work was suitable for use in the next campaign. The question was raised as to whether a basic brick can be used under reducing conditions, and Abbey felt that there was no real evidence that this could not be done. Evidence in the discussion, however, was brought out that the flue gases from a glass furnace should contain about 1½ per cent of oxygen to get the best results and that results were poor if the conditions were on the reducing side.

An excellent presentation of the use of Electro-cast high-alumina refractories was given by Dr. R. W. Brown, of the Carborundum Company. His presentation was short and to the point. The differences between Monofrax H, MH, and K were given, and recommendations made as to what positions they should occupy in the structure of a glass tank. It is of interest to note that the Monofrax K contains an appreciable amount of chromium which is present as a spinel and that there was little evidence of chrome contamination of the glass where this refractory has been used. It is interesting to find a refractory containing an appreciable amount of a coloring oxide being urged as suitable for use in glass furnaces. Apparently, glass workers who have used this refractory have not found sufficient contamination to blame it on the chrome. It will be interesting to follow the use of this type of refractory material in commercial glass-melting tanks to ascertain whether it will be established sufficiently to possibly permit the use of other coloring oxides in glass-tank refractories, which might enhance their resistance to corrosion by the glass. Fundamentally, it does not appear probable that contamination will be eliminated from a refractory bearing a coloring oxide. However, with Electro-cast type refractories, the rate of dissolution may be so low that, as the author pointed out, the actual pickup of the colorant is not measurable. The discussion on refractories was somewhat disappointing inasmuch as the refractory problem is one of the most difficult problems which the glass maker encounters in his operation. Talks with various individuals indicated that more discussion would have been advisable inasmuch as many appeared to have refractory problems of one type or another.

(*Continued on page* 57)

At the speaker's table during the informal dinner, left to right, J. L. Carruthers, H. M. Kraner, C. S. Pearce, J. W. Whittemore, R. M. Schaffert, F. V. Tooley, C. E. MacQuigg, A. K. Lyle, R. F. Brenner and H. H. Blau.

AT FIBERGLAS IT'S FELLOWSHIP

Owens-Corning Fiberglas Corporation believes that people with adequate opportunity for wholesome recreation are better employees. Members of the Fiberglas Club of Ashton, R. I., meet and play after work at the clubhouse and grounds of a former country club. The corporation's personnel credo explains why.

A Place for Work
The Ashton Plant of Owens-Corning Fiberglas Corporation.

A beautiful clubhouse is the meeting place of the Fiberglas Club of Ashton, R. I. It looks more like a country club than an industrial recreational area. It was, in fact, just that. Known as the Lippitt Estates Country Club, it was one of the features of a realty development laid out on land which was once the estate of the late Henry Frederick Lippitt, who served in the United States Senate from 1911 to 1917.

The Fiberglas Club of Ashton, one of the many personnel services offered to the men and women of the Rhode Island plant of Owens-Corning Fiberglas Corporation, is a voluntary employee group, established to give Fiberglas people an opportunity to meet and to play after their work day.

The clubhouse and the surrounding grounds were purchased more than a year ago and turned over to the employees as their recreational area. As the clubhouse had been vacant and unused for seven years, extensive repairs and renovations were necessary. After completion of these, the clubhouse was dedicated on Memorial Day, 1947, "to the everlasting memory of Ashton Fiberglas men who gave their lives in World War II".

The recreational area was purchased by Owens-Corning Fiberglas Corporation in June, 1947, after a vain search for suitable rental quarters in the nearby cities of Pawtucket and Central Falls. Located two miles from the plant, the tract includes 32 acres of land, swimming facilities, picnic sites galore, tennis courts and a golf course which are due for restoration to playing condition as parts of a long range program.

Facilities currently in use at the clubhouse include a ballroom, a game room, a reading room, a kitchen, a lounge, a sun-parlor, several small meeting rooms upstairs, a cloak room and two rest rooms. A caretaker is on full-time duty.

A beach 200 feet long on the shores of Little Pond and picnic areas are the principal out-of-doors attractions so far ready for use. Future plans, besides restoration

A Place for Play

The clubhouse of the former Lippitt Estates Country Club which is now the center of activities of the Fiberglas Club for the personnel of the plant in the Rhode Island village.

of the tennis courts and golf course, call for improvement of the picnic areas, installation of barbecue, a trapshooting range and a softball field. Parking areas will also be improved and enlarged. Fish may be stocked in two streams flowing through the grounds. It is contemplated that these projects will be undertaken one at a time and will cover a long period. Completion will depend on the interest of the plant personnel.

Ashton plant people have the pride in the property which comes with having worked on it. Because Fiberglas Club members helped with voluntary labor to renovate their clubhouse, they're seeing to it that no member or guest abuses the property. Many of the employees often spend a day off here with their families, picknicking and on the beach.

The Fiberglas Club is, of course, much more than a mere clubhouse and beautifully wooded reservation. This physical setting, however, does serve to illustrate how the Fiberglas Corporation backs up its conviction that happy people are better employees, a principle around which the personnel program has been built.

Adapted from the recreational program originated by Owens-Illinois Glass Co., one of the parents of Fiberglas, the Fiberglas Club was first established in 1938 at the Fiberglas Corporation's plant at Newark, Ohio. The Ashton plant, which manufactures glass yarn, had an informal organization embracing the basic club functions from its opening in 1941 until 1946, when the Fiberglas Club of Ashton was formally organized. There are Fiberglas Clubs at each of the company's plants at Newark, Ohio; Huntingdon, Pa.; Kansas City, Kans.; and in the Toledo, Ohio, office, in addition to the Ashton unit.

The Fiberglas Club of Ashton immediately began its career of ever-expanding service to the employees, developing a need for diversified facilities which was met with the purchase of the Lippitt Estates property.

The aims of the club are stated in its constitution. These are: promotion of friendliness, unity and loyalty among members; conduct of broad and varied athletic, social and welfare programs; fostering of healthful, enjoyable and inexpensive use of leisure time in recreative activities; offering of opportunities for enrichment and broadening of the members' lives; pursuit of community good will; coordination of and assistance in employee activities and groups through democratic means; and development of an attitude of sportsmanship and cooperation.

Seven groups form the basic units of the Fiberglas Club of Ashton. All women of A and C shifts and women working days make up Group 1. Women of B and D shifts are in Group 2. Group 10 consists of all male personnel in machine repair, alloy, general factory and steam departments and all men working days only. All A shift men form Group 6; B shift, Group 7; C shift men, Group 8; and D shift men, Group 9.

Besides conducting numerous and widely varied sports, parties and other entertainment, the Fiberglas Club has established a number of special activity units for persons whose common interests have assured success of such additional groups. Among the most recent of these are the Mr. and Mrs. Club and the Rod and Gun Club. Others will be formed as the interest for them demands.

Each group is truly a separate club in itself in that it elects a president, a vice president, a secretary-treasurer, a welfare chairman, a social chairman and an athletic chairman, besides conducting, as a compact, self-governing unit, such meetings, parties, athletic contests and other activities as its own membership wants. Thus, if Group 10 say, decides to hold a dance, the social chairman appoints a committee which assumes full responsibility, makes all arrangements and invariably conducts a dance that Group Tenners are quick to acclaim "the best ever". The Mr. and Mrs. Club is the only mixed group, but any group may invite one or more of the others to its festivities.

Broader, all-plant activities are planned by three councils—Social, Welfare and Athletic. The seven members of each are the group chairmen of the respective committees.

Over all groups and councils stands the Executive Council, the governing body, which is composed of the

Panel discussion led by Floyd S. Steinmetz, Training Director, at the club's Officer Institute where officers, democratically elected by their fellow employees, get off to a good start in teaming together to keep the club an important morale influence.
Courtesy of Fiberglas Yarns, Ashton edition.

seven group presidents, the seven group vice presidents and the three activities council presidents. The Executive Council elects from its membership a president who also becomes president of the Fiberglas Club, an honorary but not lightly regarded position. Every officer and every council member, therefore, is a duly elected person, a representative of his respective group, chosen to serve for one year.

The Executive Council, which meets monthly with the plant director of activities, Frank S. Milligan, formulates and carries out the general policies of the Fiberglas Club, stimulates and coordinates the functional officials' activities throughout the plant and supervises general club affairs. Mr. Milligan is a member of the plant personnel department. It is his responsibility to advise and assist the officers of the club in any way that he can. To equip themselves for their responsibilities, these people attend what is called an annual "Officers Institute". This is a one-day training session lasting from 9 a.m. until well into the evening. Attendance does not involve any loss of pay.

Here the various elected officers, many with some misgivings and little previous experience, are trained by a group of selected industrial recreational authorities from the corporation's general personnel department. Here they learn there is nothing mysterious about a leader, that successful ways with people and various officers' procedures can be learned. They gain that conviction by actually doing those things, in considerable detail.

Presidents learn how to plan in a pre-meeting caucus for a smooth-flowing and interesting meeting, how to use a plan sheet, where to seat all officers and any guest speaker and how to stand, speak and use the gavel properly in calling the meeting to order. They also learn the order of business and important tips on managing the meeting and on the value of friendliness, punctuality and orderliness. Secretary-treasurers learn how to keep records, handle correspondence and make reports and how to keep financial accounts, make bank deposits and pay bills. Theirs, too, is the responsibility of watching the budget and the finances of the club, for they are in full charge of all funds. The club, although partially self-supporting through revenue derived from vending machines in the plan, dues and admissions to some of its activities, still operates at a deficit. This deficit is made up by the corporation through a check sent to the Fiberglas Club treasurer.

So, likewise, with the social, welfare and athletics chairmen. They are taught to visualize clearly the goals within their respective spheres of responsibility and to plan out step by step the ways of attaining them.

Elected leaders at the institute sessions learn much from suggestions by such officials as D. A. O'Neill, General Personnel Director for the corporation; and Cloyd S. Steinmetz, Director of Training. They learn still more, with emphasis on their own specific problems, in separate discussion panels for the presidents and vice presidents, for secretary-treasurers, for athletic chairmen, for social chairmen and for welfare chairmen. These panels are led by such men as Mr. O'Neill, Mr. Steinmetz, Mr. Milligan, John W. Gregor, the Ashton plant training coordinator, and Henry Beretta, the Athletic Council president.

Still other points they learn, perhaps even long after the Institute has adjourned, from the loose-leaf Officers' Manual, a treasure trove of practical references and directions, leadership philosophy and program suggestions. They leave the Institute, informed in detail about the big job of leadership and, because they *are* informed on their probable problems and on ways of coping with them, confident that they *can* serve efficiently in their various offices.

Success of these leaders is considered a large factor in the success of the club program and, therefore, of the personnel program in general for, in contributing to their fellow employees' leisure time satisfactions, the club's leaders have had a share in developing and maintaining high morale.

The Fiberglas Club is closely interwoven with many other functions in a highly developed personnel program, the purpose of which is to establish and maintain an effective work force and the highest standards of employee-employer relationship. This program is divided into the following functions: Employment and Placement, Training, Personnel Relations, Personnel Services, Personnel Research, Administration and Related Programs.

The employment section uses modern methods of recruiting, selection and placement. These methods include a well-rounded testing program. Each new employee has a pre-employment examination, which includes a chest survey, before he is inducted into the organization.

The induction program covers the corporation's history, organization, products and manufacturing operations, as well as a thorough explanation of its operating policies and employee benefit program. This information is embellished in booklets and pamphlets that are given out during the induction. After the new employee has been taken on a plant tour, the Job Training Instructor comes into the picture. Using proven training techniques, the trainer spends as much time with each trainee as is necessary to bring his work to the minimum standard required on the job.

The new Fiberglas employee is not the only recipient of specialized training. At Fiberglas, training is a full time, year around activity, for this modern textile plant is efficiently manned by a well informed staff of trained supervisors. Training may contribute to almost any phase of production or management improvement. For

Employees pitch in on renovation jobs such as these two groups are working at.

Courtesy of Fiberglas Yarns, Ashton edition.

example, at present there is a well coordinated program of management development sessions to provide each supervisor with current information on methods, procedures and problems.

Each supervisor who, like the Fiberglas Club officers, may or may not have had previous experience in putting ideas across under formal conditions, has at his disposal the "know-how" of the training director in organizing and vivifying his subject matter. He also has at his disposal projectors, recording and playback equipment, blackboards, mock-ups and other teaching aids.

The morale threats of "too many bosses" and fear of "sounding off" have been anticipated in the Fiberglas personnel rationale by clear demarcation of authority and explicit understanding of the plant organizational structure. In the departments, the line of authority is from supervisor to foremen to group or section leaders to operating personnel. Complaints or special requests by individuals go up the line in reverse order. Any Fiberglasser may feel free, when dissatisfied with the disposition made by his immediate superior, to take his case as high as he may wish in the plant organization or even in the corporation. The recommended procedure, beyond his own department, is to the personnel director and the plant manager.

Personal tensions resulting from worry over "making ends meet" both now and in the future are cut to a minimum, insofar as an employer can help with that responsibility through good wage rates coupled with seniority observance assuring job security within the limits set up by prevailing conditions in the industry and the general economy. Serving to minimize apprehension over sickness, old age and emergency needs for cash are group insurance providing hospitalization and surgery for employees and their dependents, life insurance for employees, pension arrangements and an employees' credit union.

Service awards are granted at five-year intervals. Cash awards are made for feasible suggestions on improving plant procedures and facilities. The number of Ashton workers who have made useable suggestions runs into the hundreds. Loyal and *thinking* employees develop out of those kinds of recognition.

Information on all phases of the corporation's and plants' activities is supplied through a monthly newspaper, which is published at each Fiberglas plant. The 4- to 8-page Ashton paper, "Yarns", edited by Activities Director Milligan, is thoroughly newsworthy, containing lead articles on company policies and affairs, club activities and product uses written and displayed in accordance with professional standards of news value. It's also strong on pictures of personnel at work and engaged in Fiberglas Club activities. Columns of personals and friendly gossip for the several departments add up to considerable space; and there's always an editorial with plenty of food for thought.

By itself an important means of passing information from level to level and department to department, it is supplemented with "Yarns Bulletins" on timely happenings between issues, by bulletin board "Flashes" and longer notices, by management letters to employees in their homes, by the rotogravure "Fiberglas Pictorial" bi-monthly and by other illustrated brochures on product uses, economic outlook and miscellaneous matters issued from the Toledo general offices. These information media, Fiberglas officials feel, tend to avert the morale danger of a feeling on the employees' part that they are not being told about matters that affect them.

Some "Yarns" articles are rewritten in the daily press of the state, and Activities Director Milligan also issues news releases about plant activities as developments warrant. It is likely that this recognition in the public press contributes to the prestige of the firm in the estimation of its employees.

A realization by employees of physical well-being on the job is another asset which Fiberglas management believes to be worth cultivating. All machinery is equipped with such guards as to eliminate hazards from moving parts or hot parts or material. Cleanliness is a virtual fetish. Goggles and all other protective gear are obtainable without red tape.

An alert safety committee meets weekly to discuss problems and develop preventive programs. New safety information goes through department channels so that passing the buck is out of the question in case of accident resulting from non-observance of safety regulations. The effectiveness of this program can be measured by the extremely low accident frequency rate held by the plant and by the low workmen's compensation cost.

The plant-fire brigades, a volunteer organization, holds periodic fire drills, makes weekly inspections of hydrants, extinguishers, sprinklers and other equipment, besides having trained men ready throughout the plant to start fighting any incipient fire.

A cafeteria located in the plant and operated on a non-profit basis provides low cost meals for employees on all shifts. The plant also maintains a well equipped first aid room under the supervision of a plant physician and attended by a registered nurse on each shift.

To be or not to be formal in personal relationships on the job is one question which has never bothered Fiberglas people. The firm is definitely a "first name" organization. And that goes as between Harold Boeschenstein, President of the corporation, and a sweeper on a plant floor. Plant Manager Jones is Harry to everybody in the plant.

Mr. Boeschenstein and the other top level executives get around. Frequently, visits are made to every

(*Continued on page* 55)

Ashton Fiberglassers at a New Year's Eve party in the clubhouse.

Courtesy of Fiberglas Yarns, Ashton edition.

MELTING OF COLORLESS GLASS IN THE ELECTRIC FURNACE AND ITS DEVELOPMENT IN SPAIN

By JUAN FINGER

Sociedad Anonima de Hornos Automaticos
Barcelona, Spain

The electric melting of glass has been developed and improved in such a manner that at the present time it may be said that only two problems remain which limit the introduction of the electric furnace in the glass industry: *First:* The high cost of installation and the cost of melting, frequently higher than that of fuel-fired furnaces. *Second:* The difficulty of obtaining a completely colorless glass.

Considering the first difficulty, we have designed in Spain, for the purpose of reducing the cost of installation, very economical types which are frequently connected directly to the 220-volt circuit and working at a constant voltage, whereby the total cost of the installation in general does not appear to be higher than that of a furnace of equal production, equipped with recuperator and gas-producer, using coal as fuel. The power consumption of the furnaces, according to our experience, is shown in Fig. 1. In practice, it is always necessary to make an increase of about 8% to 10% for electrical losses in transformation and conduction.

The main difficulty found by the manufacturers of the furnaces in question consisted in obtaining a completely colorless glass, or at least of as good color as that obtained with any tank furnace using fuel oil or coal. The origin of additional, usually green, color over that obtained with other types of furnaces must be discussed.

The coloring would originate principally from the iron oxide contained in the raw materials of the glass batch or acquired during the melting, and from the condition of oxidation of the iron in the glass, which depends upon various factors, such as melting time, the existence of reducing or oxidizing elements in the glass, and the range and control of temperatures during the melting.

In general, iron may be found in the glass in the form of Fe_2O_3 or FeO. Fe_2O_3 gives to glass a light greenish color and FeO a dark greenish color, rather bluish. Apparently the iron is generally found in the glass in the form of Fe_2O_3 and if during the melting there is a possibility of reduction, it transforms itself into FeO. This transformation is generally rather slow, so that if the glass remains for many hours in a melted state, it progressively shows a change in shade toward dark and green-blue, the change in color being extreme after some days.

When the melting of colorless glass is undertaken and there are in the raw materials small quantities of iron, as for example about 0.2% of Fe_2O_3, it is advisable that all the iron be maintained insofar as possible in the form of Fe_2O_3 with a light greenish shade, with which it may fulfill the necessary esthetic requirements; but the reduction of the iron to FeO, with its bluish-green shade, may cause the ware to be rejected because of insufficient "flint," "crystal," or colorless character.

As usual limits, the maximum quantities of Fe_2O_3 that may be permitted in glass for different uses is given in the following table:

Semi-crystal glass	0.25%
Sheet glass for windows	0.20%
Domestiç flint glassware	0.12%
Pressed crystal glassware	0.04%
Fine glassware	0.02%

As for the quantity of iron contained in the glass from the electric furnace, compared with that from other methods of melting and assuming that the same ingredients are used, we must investigate whether or not there are any other sources for the introduction of iron peculiar to the electric process.

First to be mentioned is the dissolved refractory, which sometimes contains a notable percentage of iron that may have great influence in coloring the glass, perhaps because of the presence of Al_2O_3. The quantity of refractory dissolved, making a comparison between both types of furnaces, may be higher in the electric furnace, provided that the work is carried out at higher temperatures than in the fuel-oil furnace, or else that there exist places of concentration of temperature near the refractories which may bring about a more rapid dissolution of them.

The influence of the refractory on the color will, of course, always be greater in small furnaces with an area of contact between the glass and the refractory rela-

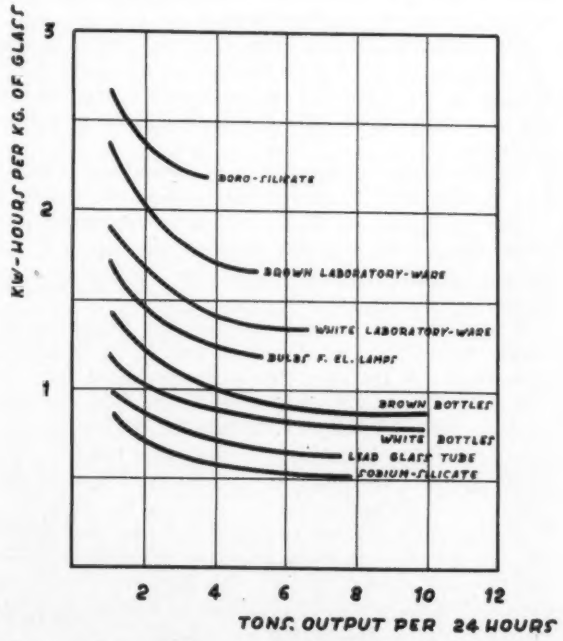


Fig. 1. Consumption of electric glass melting furnaces.

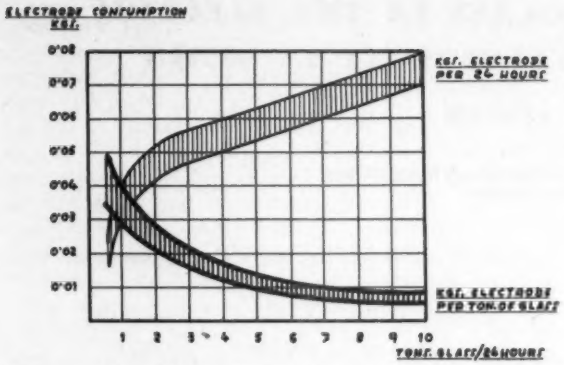


Fig. 2. Consumption of amorphous carbon electrodes for ordinary flint glass.

tively greater than in furnaces of larger size. The importance of the iron introduced by the refractory in a furnace of 3 tons, for example, would be approximately the following: In this furnace of 3 tons per day there are probably produced about 1,000 tons of glass per year, dissolving at the same time about 5 tons of refractory. If this refractory should be of bad quality, it might have 1% of Fe_2O_3, representing about 0.005% in the glass, so that, as it may be observed, the quantity of iron introduced is not important, except in the case of fine crystal, in which this quantity represents a great part of the total iron allowable. This difficulty may be avoided through due precaution on the part of the manufacturer and in the use of the furnace.

Other sources for the introduction of iron which are characteristic only of the electric furnace may be found in the electrodes. Generally, there are used electrodes of amorphous carbon, graphite, or pure iron. These three types are considered as the only ones of interest from an economic standpoint for the melting of the more or less common glass, since the use of other materials, such as platinum, might be justified only for very special glasses, or very high price.

The electrodes of pure iron, it is not difficult to suspect, always let loose some quantity of iron and introduce it in the glass, for which reason we consider it almost impossible to obtain colorless glass with iron electrodes.

The electrodes of graphite and carbon may contain iron in negligible quantities, only millesimal, and in a further paragraph we shall see that the introduction of these particles of iron may have no importance if the furnace is properly constructed for consuming electrodes only slowly.

In regard to the second circumstances having an influence in the color of the glass, that is, the condition of oxidation of the iron, this is always rather unfavorable in the electric furnace as compared with the fuel furnace. This is because of the fact that the electric furnace has always a tendency to introduce reducing elements in the glass, such as the dissolved iron of the electrodes or the carbon proceeding from the electrodes. This second inconvenience, besides the prejudice to the color of the glass upon the reduction of the ferric oxide and the reaction of its oxygen with the carbon, produces carbon dioxide, which in the form of bubbles may remain in the glass and create a new defect.

If the glass contains any other easily reducible metal, a difficulty will always arise in electrical melting. This occurs especially with lead glass, or crystal, since the plumbic oxide in the glass reacts to a large extent with the electrodes, accumulating sometimes in the bottom of the furnace certain quantities of reduced metallic lead. For this reason, while we ordinarily manufacture in Spain lead glass for tubing such as is used in the manufacture of electric lamps, we have not decided to install a furnace for colorless lead glass of fine quality for glassware.

The consumption of carbon of the electrodes will depend upon the quality of the same and upon the current density applied, as well as the general temperature of the glass and other characteristics of the furnace. In Fig. 2, we give an idea of the average consumption of the carbon electrodes which we use in Spain for electric furnaces for glass. It is immediately noted that the risk of producing additional coloring in the glass is always greater in the small furnace than in the large furnace. However, in view of the small quantities of carbon dissolved, it may be said that the reduction due to the carbon of the electrodes in the furnaces of the type we use in Spain is of little importance and easily overcome by means of the introduction of oxidizing agents, such as nitrates.

Another factor which has an influence on the color of the glass is its thermal history (*Wärmevergangenheit*). In general, the glass that remains for a longer period of time in the furnace is greener because of the transformation of Fe_2O_3 into FeO. Melting at very high temperatures also causes the color to be more evident by facilitating that transformation. There is generally an advantage with the electric furnace as regards the period of dwelling or retention of the glass in the furnace, since we have reduced it to about 25 hours. But there exists the tendency toward the use of high temperatures because of the ease of obtaining them and the custom of the glass maker to solve refining problems with temperature.

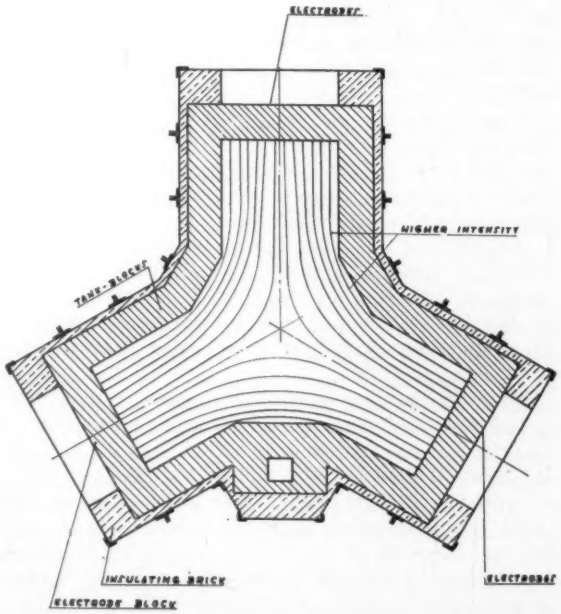


Fig. 3. Electric current lines in a real triphasic furnace.

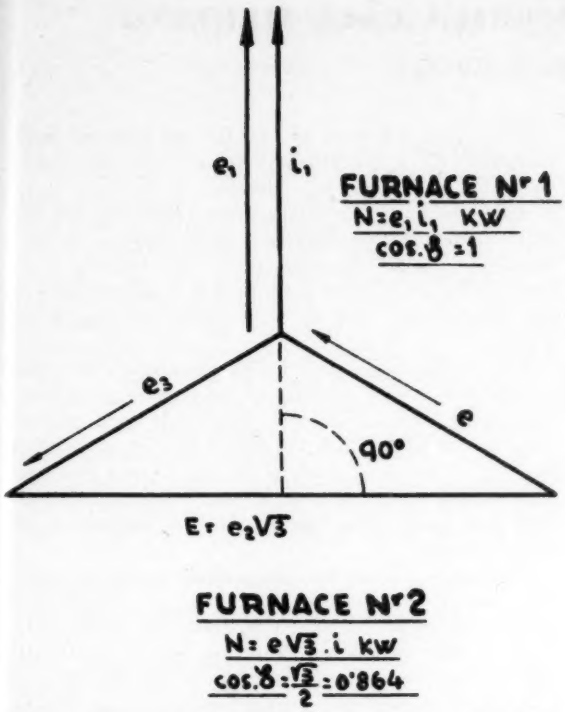


Fig. 4. Connection of 2 monophase tanks in a three-phase system.

In view of the foregoing, it is evident that the electric furnace offers certain difficulties in obtaining a completely colorless glass. In our constructions in Spain and Portugal, we have been guided in the first place by great caution as regards the distribution of heat in the furnace, and we do not exceed the necessary temperature for a normal refining. For this reason we avoid three-phase furnaces, which, in the most logical form of a star (Fig. 3), offer the risk of an increase in intensity and temperature in the internal corners. Likewise, we have not used in our furnaces iron electrodes and we endeavor especially to avoid an overheating of the glass around the electrodes.

With these measures it was possible, in the course of a comparative campaign carried out with an electric furnace and a fuel-oil furnace, to obtain a more colorless glass with the electric furnace. These results were obtained with the use of relatively high voltages, since in this manner, upon reducing the intensity of current, it was possible for us to reduce the cross-section of the electrodes used and thereby a part of the possible causes of undesirable color.

In general, three-phase alternating current is employed in Europe for large industrial uses, and in view of the great capacity of glass furnaces, the electric supply companies do not as a rule permit the installation of furnaces of one single phase.

For this reason, and in order to avoid the difficulties experienced in the immediate application of three-phase current for the melting of colorless glass, we have been looking for acceptable solutions, such as the use of several single-phase furnaces in such a manner that a balance is obtained in the triphasic net, as for example by means of the separation of the three phases in the following manner:

Two phases disposed for one furnace and another single phase for another furnace. When it concerns 3 equal furnaces, it may be done with greater facility using one phase for each furnace.

Two equal furnaces may be balanced in the triphasic supply with transformers in Scott connection.

When it is desired to connect only one furnace, there exist also connections which are more or less satisfactory, using for example the two phases combined for the melting by means of a single-phase tank, and the third phase for heating the working chamber, whereby, and especially in such small units, a rather perfect balance is obtained.

In general terms we believe that, since in the United States there exist electric power networks of great capacity, there is no need of resorting to such procedures, inasmuch as single-phase furnaces, relatively large, directly connected in the manner deemed more suitable, will be permitted.

Summarizing, we believe that the goal of obtaining a perfectly colorless glass depends over all upon homogeneity in the temperature in the furnace; avoiding the direct use of the three-phase current; and the use of electrodes of good quality, preferably carbon. At the same time it would be advantageous to use high voltages.

OWENS-ILLINOIS ANNOUNCES PRICE INCREASES ON CLOSURES

Owens-Illinois Glass Company has announced price increases of approximately 10 per cent on its metal and plastic closures for glass containers effective January 1, 1949.

Products involved in the increase are screw and lug type metal closures made generally of tinplate and also stock and private design plastic closures made of phenolic and urea formaldehyde molding compounds.

Mr. H. J. Carr, company Vice President and General Manager of its Closure and Plastic Division, cited the recently announced increase of between 11 and 14 per cent on tinplate and previous increases in aluminum sheet, lithographing and coating materials, plastic molding compounds and linear materials, coupled with the third round of wage and salary increases as making these price increases unavoidable.

CONSUMERS GLASS ELECTS J. N. JORDAN AS DIRECTOR

At the annual general meeting of Consumers Glass Co., Ltd., J. N. Jordan, workers manager of the company, was elected to the Board of Directors filling the vacancy on the Board created by the death of J. A. Kilpatrick.

The new Director has been with the company for 22 years and has held various positions during that time. A McGill University graduate, he served with the Canadian Field Artillery during World War I.

OPTICAL SOCIETY OF AMERICA FALL MEETING

As in other years, the sessions of the Optical Society of America recently held in New York City were divided into two groups: one dealing with spectroscopy and the other with more general optical problems.

The paper of Carl E. Foss, "A Classification of Color Order Systems", although similar to one which he gave before the Ceramic Society in Atlantic City, was of interest to those of the glass industry who deal with color problems. Mr. Foss pointed out that color systems may be classified according to the principal differences upon which they are built. The three classifications which result are systems which depend 1) on the colors mixed, 2) the colorants mixed and 3) on the visual spacing of colors.

Robert W. Burnham's paper, "Comparison of Color Systems with Respect to Uniform Visual Spacing", was a good summary of various color notation systems, particularly those which attempt to show visual differences proportional to linear distances. W. R. L. Brown and D. L. MacAdam's paper, "Visual Sensitivities to Combined Chromaticity and Luminance Difference", added the factor of luminance to the earlier investigations of MacAdam. Richard S. Hunter's report, "Accuracy, Precision, and Stability of New Photoelectric Color Difference Meter", indicated the accuracy of the new Color Difference Meter.

Other papers which glass technologists interested in color will wish to read are: "A Comparison of Direct Colorimetry of Titanium Pigments with Their Direct Colorimetry Based on Spectrophotometry and a Standard Observer" by Deane B. Judd (in which he indicated the necessity of the reexamination of the ICI Standard Observer below 460 millimicrons) and "The Berold-Brucke Phenomenon and the Hering Theory of Vision" also by Judd.

Those glass technologists interested in the optical properties will be interested in the following papers: "Measurements of the Physical Properties of Infra-red Optical Materials" by Lewis S. Combes and Stanley S. Ballard and "The Infra-red Properties of Polar Crystals" by Elias Burstein.

Two papers, although not of specific interest to the glass technologist, attracted sufficient attention that they cannot go without mention in this report. The first was Ralph M. Evans', "Seeing Light and Color". This was an excellent address presented in a very interesting manner, colored slides of outstanding quality being used to present the ideas. Although the address resembled Evans' book on color, there seemed to be an extra factor which this correspondent likened to motion. The ability to present slides one after another brought out some points much better than is possible in a book. The second paper of general importance was presented by R. M. Schaffert and J. C. Wilson and entitled "Xerography a New Principle of Graphic Reproduction". This process attracted considerable attention due to the fact that with it one can reproduce drawings in 38 seconds as was demonstrated before the convention. So far the method, which depends on the loss of charge by a semi-conductor surface when illuminated, works well for reproduction of line drawings but does not work as well for the reproduction of halftones. By a modification of the process the authors were able to turn out reproductions of drawings as fast as they could run the rotary press (1200 feet per minute). Although this could not be interpreted as basic reesarch, it attracted considerable attention due to the fact that it could create a revolution in several fields of the graphic arts and in reproduction of engineering drawings.

This correspondent noted with satisfaction the steady though slow annual increase of the type of presentation that arouses audience interest. Invariably these presentations are those in which the writer tells in an informal manner, by means of a few slides and using a few notes, what he has done and what he has found. He does not read and leaves long mathematical derivations to the written paper.

The dinner meeting was not as lively as in some years. The Adolph Lomb medal for 1948 was presented to David S. Grey of Polaroid Corporation for outstanding work in lens designing. Professor Stanley S. Ballard reported on his European meetings of the past summer particularly regarding the establishment of an international optical society. This organization will be a rather loosely knit one which will serve as a means of encouraging the international exchange of ideas, information and personnel.

The brilliant event of the dinner meeting was the speech of Dr. C. F. Kettering. His informal style and use of simile and metaphor made his address both interesting and easy to "listen to". Dr. Kettering drew on one of his early interests, photosynthesis, to point out that all life stems from the sun by means of the radiation from it. It was therefore possible, he concluded, that the solution of many fundamental problems of science would be solved by the optical scientists.

WALSH REFRACTORIES EXPANSION

Announcement has been made by J. L. Crawford, Vice President & General Manager, of the purchase of property by Walsh Refractories Corporation. The newly acquired property will be the site for a modern, air conditioned office building and will also provide additional warehousing facilities. The building will be ready for occupancy in about three months.

Continued heavy demand in world markets for Missouri-made fire clay products has necessitated expansion of the company's facilities, Mr. Crawford stated.

CAMBRIDGE WIRE CLOTH VICE PRESIDENT DIES

The death of Robert W. Pink, Vice President of Cambridge Wire Cloth Company, has been learned.

Mr. Pink had been associated with the company as Vice President since its founding and was a well-known figure in the industries served by the company.

APPLICATION OF THE EMANATION METHOD TO GLASS RESEARCH

In spite of Hahn's[1] suggestion of the possibilities which the emanation method may hold for problems of the glass industry, his work on the attack of water vapor on glasses of varying durability was followed by only one publication[2] having some bearing on glass technology. Since this method has been developed to give partially quantitative methods, and its utility and limitations have been explored, it appeared to be attractive to investigate to what extent it could be applied to glass research. Difficulties in operation have been overcome and according to recent developments[3] it became possible to have automatic recording of emanation vs. temperature. To stimulate application, however, chemical research has to prove systematically that glass technological problems can be solved by the emanation method. These possibilities will be shown up in the following.

Experimental Procedure

For the determination of the emanation, a glass is treated as follows: a) It is melted with thorium X, the parent product of thorium emanation (for homogeneous tracing of the sintering or melting process, of water vapor attack and so on) or b) A thorium X solution is evaporated on the glass surface (for tracing of the surface to determine the transformation range, etc.).

A constant velocity gas stream (nitrogen from a cylinder, or air by means of an aspirator) is directed over the glass to be tested, which gas stream carries away the emanation developed by the thorium X and which escapes from the glass, through a drying tube to the measuring equipment.

The amount of emanation delivered from the sample can be measured by the rate of discharge of an x-ray electroscope (see Fig. 1) or by the deflection of an electrometer.[4]

In either case the gas carrying the emanation will be passed through an ionization chamber F in which the ionization, which is proportional to the amount of emanation present, will be measured. In the case of the simple electroscope this will be indicated by the time necessary for the gold leaf to deflect between two marks on a scale. When using an electrometer a D.C. voltage will be applied to the chamber and the resulting current will be measured. Further details of the circuit of an electrometer tube according to Zimens[5] are shown in Fig. 2. The ionization current flows through a resistance R in which it causes a potential difference. If this resistance is inserted between cathode and grid, the grid potential will change proportionally to the ionization current, that is, proportional to the amount of emanation passed through the chamber per time unit. Changes in grid potential are indicated by current changes in the ammeter.

Since the ionization current has a magnitude of about

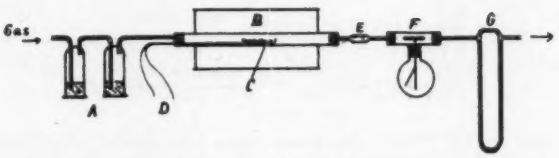


Fig 1: A) drying flasks, B) electric furnace, C) boat with sample, D) thermocouple, E) drying tube, F) ionization chamber, G) gas velocity meter.

10^{-10} amp and the voltage is to be about 1 volt, the resistance should be about 10^{10} ohm. Impregnated cellulose, as marketed for insulation purposes under the name "Fiber," has such a resistance. If desired, liquid resistors may be used.[6]

The grid potential can be adjusted for any electron tube by means of potentiometer P_1 and with the one used was about 3 volts. The galvanometer G is adjusted to zero by means of potentiometer P_2.

For automatic recording of the emanation vs. temperature curves an even temperature increase has to be provided and the time curve of temperature and emanation has to be recorded synchronously. Both the temperature and emanation can be measured with mirror galvanometers and the reflected light beams can be recorded on a film driven by a clock work.

The following experiments carried out with the above equipment will throw some light on the applicability of this method for glass research.

1) Sintering and Melting of Glass Powders. A better understanding of the sintering phenomena of glass may be of interest with respect to the melting of cullet. This problem probably is of much less importance than the investigations, which will be shown later, on the behavior of glass powder when melting a glass batch. The sintering experiment, however, was undertaken to have a simple example for the interpretation of emanation vs. temperature curves.

For this investigation powdered $Na_2O \cdot SiO_2$ was used which was melted with radiothorium, the parent substance of Thorium X, which in turn decomposes to thorium emanation. After remelting the glass twice it

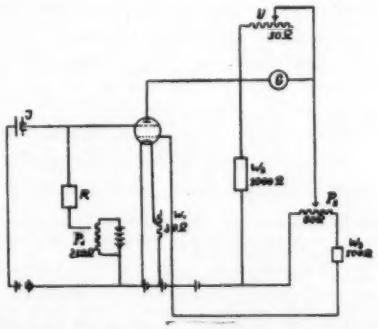


Fig. 2. Current diagram: J, Ionization chamber; G, Galvanometer; R, "Fiber"-resistance; P_1, P_2, Potentiometer; U, Variable resistance for galvanometer adjustment; W_1 Resistance for variation of heating voltage; W_2, W_3, Constant resistances.

Nils Arberg, Arkiv For Kemi, Mineralogi Och Geologi, *18A*, No. 15, 1944.
1 O. Hahn and H. Müller, Glastechn. Ber. I, 380, 1929.
2 M. Heckter, Glastechn. Ber. *12*, 156, 1934.
3 See R. Jagitsch, Chalmers Tekn. Högskolas Handl. (Goteborg) No. 11, 1944—K. E. Zimens, Z. phys. chem. (A) *191*, 1, 95, 1942; *192*, 1, 1943.
4 H. J. Born, Z. phys. chem. A, *179*, 256, 1937.
5 K. E. Zimens, Z. phys. chem. A *186*, 94, 1941.
6 See H. J. Born, loc. cit.

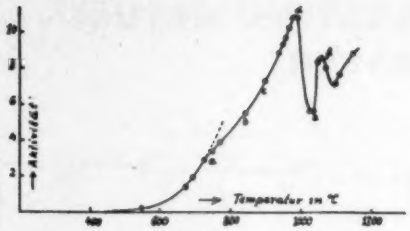


Fig. 3.

Fig. 3. a) 725°C. Deviation from exponential character of curve. Incipient increase in grain size, b) 840°C. Grains caked somewhat, c) 900°C. Glass sintered, d) 985°C. Incipient melting, e) 1030°C. Mass melted, but opaque, f) 1060°C. Clear melt.

was ground. A sample, —16 to +100 mesh/cm², was heated in a furnace with constant temperature increase up to the melting point. The change in emission with temperature due to sintering and melting is shown in Fig. 3.

Due to the small diffusion rate of emanation through glass the activity is very small at lower temperatures. It increases rapidly at higher temperatures. Departures from exponential increase due to changes in the sample because of caking, sintering, and melting can be seen from the diagram.[7]

2) Determination of Transformation Range of Various Glasses. When cooling glassware after molding, stresses are formed due to progressive cooling from the outside to the inside of the melted glass. These stresses—compression on the surface and tension in the interior—are rapidly equalized above the transformation range. Below this range equilibrium is reached much slower, and more than 100°C. below it they will persist. Therefore, rapid cooling is permissible above the transformation range; sufficient time, however, must be provided for cooling in this critical range. Exact knowledge of the transformation range is of extreme importance for proper cooling.

For the determination of the transformation interval the emanation method offers a simple method which, compared with other methods such as conductivity measurements of glass samples, has the advantage of not only showing the transformation temperature but also the *width* of this critical range.

As shown above, the rate of diffusion of emanation atoms through the glass is too small at temperatures below 500°C. to allow the use of glass with homogeneously distributed tracer emanation. Accordingly, radiothorium has to be applied to the *surface of the glass grains.* This procedure was also chosen since it is the only one which allows observation of the important changes in the surface skin of the glass.[8]

The emanation activity shows analogous temperature functions for all glasses investigated and, therefore, can be dealt with summarily. When heating the glass samples, the number of emanation atoms going into the gas phase will increase due to their increasing velocity (temperature range a.). Even with this tracer method, where the parent product of emanation has been applied to the glass surface, about half of the emanation atoms which are formed in equilibrium will be projected into the interior of the sample due to radioactive recoil.[9] That these atoms start to diffuse out of the border layer at the relatively low temperatures observed appears to indicate a noticeable destruction of the surface layer. Possibly swelling[10] of the surface is caused by evaporation of the tracer solution in the preparation of the samples.

Above 350°C. aging becomes noticeable as a decrease in emanation activity (temperature range b.). The diffusion velocity of the emanation atoms projected into the interior on decay of the Thorium X atoms decreases noticeably. It is known from evacuation studies of glasses, that degassing of the surface is quite rapid in this temperature range, while gas diffusion from the interior is negligible.[11] At the temperature of incipient transformation the regeneration of the surface must increase due to the increasing mobility of the elementary units and decrease of emanation should rapidly come to an end due to this orientation. Emanation activity should, as long as noticeable diffusion of Thorium X atoms into the glass interior does not occur, increase again

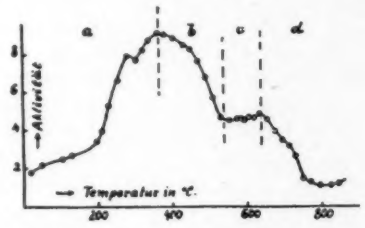


Fig. 4. Glas Nr. 2: SiO_2 75,7 %, Na_2O 13,0 %, CaO 11,3 %.

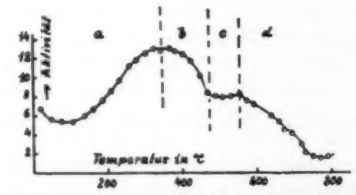


Fig. 5. Glas Nr. 3: SiO_2 72,3 %, Al_2O_3 1,0 %, Na_2O 15,2 %, K_2O 0,7 %. CaO 10,4 %, Fe_2O_3 0,1 %, MnO 0,13 %.

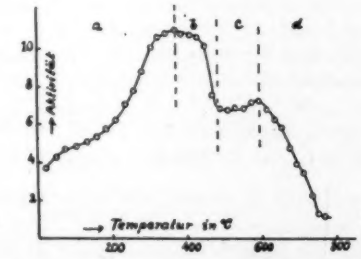


Fig. 6. Glas Nr. 4: SiO_2 69,5 %, Al_2O_3 3,7 %, Na_2O 16,2 %, K_2O 0,9 %. CaO 9,25 %, Fe_2O_3 0,1 %, MnO 0,8 %.

[7] The irregular shape above 1060°C., that is after melting of the glass, is due to the spreading of the glass in the boat and is without interest for the present considerations.

[8] For readers less acquainted with radioactive tracer methods, it should be pointed out that these tracers are used in nearly weightless amounts, such as in the present case of about 10^{-8} g RdTH per gram glass. Since this small amount of radiothorium—about 10^{-8}cc—is distributed over a surface of about 100 cm² a less than monomolecular layer will result when assuming even distribution. Even for less even distribution the observed emanation will have to be attributed to the glass proper rather than to the tracer in view of the radioactive recoil.

[9] On recoil in glass, see M. Heckter loc. cit.

[10] See W. Gefken and P. H. Prausnitz, Kolloid Z. *86*, 11, 1939.

[11] See J. A. Hedvall and R. Jagitsch, Chalmers Tekn. Högskolas Handl. (Göteborg) No. 19, 1943.

on further temperature increase due to the rapidly increasing diffusion rate. Actually, as shown by experiment, this increase in activity is barely noticeable, since the parent substance of the emanation, the barium homologue Thorium X, starts to diffuse noticeably into the glass interior.

Accordingly, the transformation range (temperature range c.) is shown up in the EV-temperature diagram as a nearly constant emanation activity.

With increasing temperature due to rapidly increasing mobility of the glass structure the surface will rapidly be depleted in Thorium X, and the emanation activity will fall off rapidly (temperature range d.).

In the following examples (Fig. 4-6) the change in emanation activity with temperature is shown graphically for three different glasses. The respective compositions are given in the legend.

Comparing the transformation ranges obtained in this manner with the transformation points obtained from the temperature dependence of the electric resistance shows that the latter corresponds to the mean of the transformation range (see the following table):

Glass No.	Transformation Range Emanation Method	Arithmetic Mean Thereof	Transformation Point From Electric Resist.
2	550-640	595	583
3	475-560	517	521
4	500-590	545	540

Finally it may be mentioned that glasses rich in alkali, that is glasses not satisfactory for practical application, show no marked transformation range.

The present investigation is to be extended to further glass technological problems.

R. R. Underwood and Lee W. Minton

R. R. UNDERWOOD HONORED BY GLASS BLOWERS' ASSOCIATION

R. R. Underwood, President of Knox Glass Associates, was presented with the honorable withdrawal card by the Glass Bottle Blowers' Association of the United States and Canada. This is the first card of its kind ever issued by the international association since it was founded in 1846.

Mr. Underwood has been a member of the Association for nearly 40 years and, according to Lee W. Minton, President of the International and who made the presentation, he is the only individual associated with the International who is a member and also an employer. Mr. Minton added that "a presentation such as took place here this evening is unprecedented in the history of the glass bottle industry and makes Mr. Underwood a perpetual member of our international organization."

In addition to the withdrawal card with his name, "R. R. Underwood, Esq.," inscribed on the face, Mr. Underwood's name also is printed in gold lettering on the face of the black leather folder in which the card was placed. A plaque of the honorary certificate was also presented to Mr. Underwood for display in his office.

In accepting the card and plaque, Mr. Underwood said, "I am grateful for my membership in the Glass Bottle Blowers' Association and greatly appreciate my membership in this organization and the circumstances which bring about the presenting of this withdrawal card and plaque to me." He further stated, "Knox was started with a capital of between $5,000 and $6,000 back nearly 40 years ago, and today Knox Glass holdings are worth between 16 and 17 million dollars. One thing that was important in reaching this great success was my fellowship with this great union."

Master of ceremonies for the occasion was Carl L. Clover, Director of public and industrial relations for Knox Glass Associates. Other speakers of the evening were Charley Wright, Vice President of the union, Ray Dalton, executive officer of the Association, and George B. Underwood, Assistant to the President of Knox Glass Associates.

FOUNDER OF KIRK & BLUM DIES

R. J. Blum, Sr., co-founder and President of the Kirk & Blum Manufacturing Company, died at his home. Going into semi-retirement 18 months ago because of a heart ailment, Mr. Blum still made occasional visits to his business.

Born in Cincinnati in 1886, Mr. Blum met the late Sylvester W. Kirk nineteen years later to organize the company which is now one of the country's leading fabricators of dust-collecting and fume-removal systems.

CLARENCE M. BROWN OF PPG CELEBRATES 80th BIRTHDAY

Clarence M. Brown, Board Chairman of Pittsburgh Plate Glass Company, was feted on his 80th birthday by the firm's officers following a regular meeting of the Board of Directors.

Mr. Brown has been associated with Pittsburgh Plate Glass Company since 1895 when he joined the company as secretary and legal advisor to the late John Pitcairn, one of the founders of the firm. He has served as Director of the firm, general counsel, Vice President and Board Chairman.

GLASS MELTING

By GEORGE E. HOWARD

Consulting Engineer, Butler, Pa.

PART III

The Erosion Method of Glass Melting

The present chapter of this general presentation will deal more specifically with the features that distinguish it from the conventional method of glass melting. The general principles were discussed and sketches shown, it being assumed that the heretofore described mechanism may be used for carrying these principles out. In a broad sense, both systems necessarily involve the action of erosion, chemical solution, diffusion by temperature, etc.

The differences are specific and provide leads for the engineering of mechanism which can eliminate many of the defects of conventional tank melting, and provide advantages over the latter method otherwise inherently impossible to attain. The sketches are illustrative only and give a picture of proportions, actions, etc. which are necessarily only approximate. We know very little of just what takes place in the melting of glass by any method especially during some of the earlier stages of chemical action. We know the materials we put in and the product we take out to some extent.

When we consider the fact that much of the phenomena is molecular and that a grain of sand $\frac{1}{16}$" in diameter contains molecules somewhere on the order of 140 quintillion, no instruments are available that give us direct observations. Moreover, the mechanism used, the high temperature and incandescence involved would likewise prevent this. We do know some facts about viscosity of molten glass at the temperatures used and the various chemical proportions involved. These with much other data on such matters as devitrification, liquidus, etc. should furnish sufficient background to visualize what takes place and provide the basis of design for actual trials which must be the final criterion of the practicability and desirabiilty of this process.

Fig. 4 shows a somewhat ideal disposition of the particles, A silica, B lime, and C soda, mixed as batch either loose or in briquette form. Figs. 5 and 6 illustrate particle arrangements which with many others are doubtless always present in commercial batch mixing. Fig. 7 shows a number of units, such as Fig. 4, perfectly mixed where the soda and lime have begun to form a liquid and where the combined action of the soda and lime soda liquid has begun to dissolve the silica grains A.

Fig. 8 shows further reduction in the size of the silica particles. Fig. 9 shows the disappearance of the silica grains and the elongation of these grains into the fine striae which cause the glycerine and water effects which is the final condition of melting and immediately precedes the completed plaining operation.

The latter operation usually takes place in a separate compartment or an extension of the melting compartment. Here a high flame temperature is maintained for a long period over a large surface. The glass here reaches its highest temperature and lowest viscosity. Convection currents are at a relative high travel rate and this condition permits the slow clearing up of the cordy condition by diffusion.

In Figs. 4 to 7 inclusive, the materials are indicated by circles. In Figs. 8 to 10 inclusive, the liquid, becoming highly fluid, is indicated by shaded lines and only the silica shown as individual units. Figs. 4 to 9 inclusive, represent the conventional method of melting wherein the desired proportion of materials is as homogeneously mixed as possible in the dry granular stage and an attempt made to maintain such homogeneous condition during the melting cycle.

Inasmuch as the best dry mixing only approximates the desired ideal and the approximate condition of homogeneity not only is not maintained but deteriorates in the conventional bath or tank melting operation, it is usual to limit the proportion of silica to some proportion lower than desired. Otherwise individual particles of silica are carried in the glass and even with prolonged plaining would not contact all the solvents to complete the plaining. Although the specific gravity of these minute silica particles is higher than the molten glass, they are carried by the convection currents just as heavier particles are carried in water as an emulsion when the water is agitated.

The silica particles are never ideally spaced so that each is evenly located in contact with the exact amount of surrounding solvents necessary to finally produce a perfect product. As a result, only 75% of the glass as silica is practical in commercial melting. What is true of silica is also true of many other refractory materials which tend to improve the final product but which cannot be

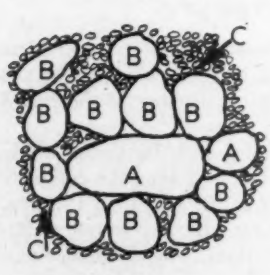


FIG. 4

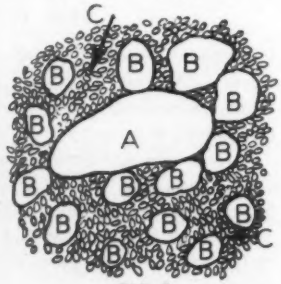


FIG. 5

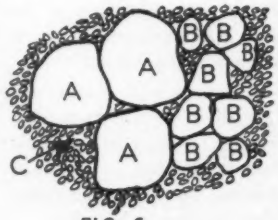


FIG. 6

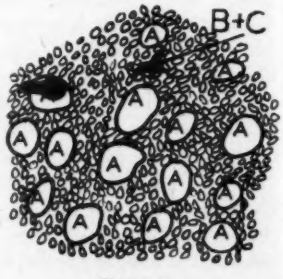


FIG. 7

FIG. 8

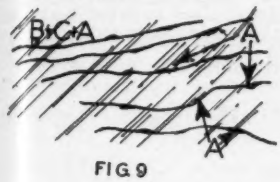


FIG. 9

used, at least in the amounts desired, owing to the factors above described. There is another factor of perhaps greater practical importance. Materials dissolved in fluids reach a saturation point and thereafter no more can be absorbed.

This is true of silica and its solvents, salt and water etc. As the solution reaches its limit, the "greediness" of the solvent to absorb diminishes and finally becomes so slow and inert that the time necessary for complete solution is long. With cold solutions, this is often not important as time is not a running expense.

With glass plaining, the fuel necessary to maintain temperatures until each particle finally contacts its mate and is wedded thereto is often prohibitive for even an ideal mixture. This is a most important point, and is the main reason for the ability of the erosion method to dispense with or greatly reduce plaining and at the same time to absorb a higher per cent of silica or other materials refractory to solution if desired. The same phenomenon occurs in the combustion of gas and air.

In a small Bunsen burner, it is possible to get a nearly perfect proportion of gas and air and leave neither CO or O in the products of combustion. It is also possible to confine the hot area to a small space and effect complete combustion in a short period of time. With the large cavernous ports of the regenerative tank furnace, additional air is necessary in commercial operation. This may be as much as 10%. Likewise with a glass batch so proportioned with the maximum desired per cent of the critical refractory, such as silica, if each particle is to contact its mate, either a particle arrangement must be perfect (an impossible ideal commercially) or time and movement must be prolonged or all 3 conditions met together.

Now with these factors confronting us, if we want glass easily melted, quick and complete solution of the silica and generally good control limits for operating conditions, we have to provide an excess of solvents because of an insufficient number of contacting particles if for no other reason.

The high percent of solvents and the preheated briquettes would insure a rapid transformation from solid to pasty to liquid in a relatively small space and short time. The expulsion of the gases formed from the moisture of certain materials, changes in the lime, gases of formation from chemical combination, etc. would be free to escape through the interstitial spaces in the upper portion of the shaft furnace.

Referring now to Fig. 10, we see the true erosion action. Large lumps A of silica are washed by the (A + B + C) liquid flowing by gravity over them in a thin sheet, or drops or fine streams. This streaming over or washing continually renews the contact point of the molecules of the silica and the liquid. This picks up additional silica, the rate of addition to the liquid being determined by the composition of the liquid, the temperature, the area in contact, the time of contact and the rate of flow.

Grains or particles of soda do not coalesce with grains or particles of silica for example. Only molecules coalesce, and that is why one material (in this case silica) would best be stationary to permit the flow of the liquid over and in contact with the refractory material, and thus constantly and controllably determine the final desired proportions.

Per contra in the conventional tank melting compartment, these particles are dumped cold into a hot viscous bath where they "bumble around" in slowly moving currents, boiling and bubbling by chemical action, and giving a superficial picture of efficient mixing. But, it is only superficial. Actually, and thanks to efficient preliminary mixing and luck, we do attain a reasonable degree of uniformity on the average, but with unnecessary long time and high fuel cost.

It is better for the present to forget about convection currents and particles and attempt to visualize molecules and their action upon each other. It is not difficult to do so. It does not require higher mathematics, chemistry, or physics for the reader to understand. Common sense and a reasonable or garden variety genius for visualization is sufficient. Grains of soda do not dissolve grains of lime, silica, etc. The chemical junction is one of a molecule contacting and uniting with another and different molecule.

A grain of sand (A), Figs. 4 to 7 inclusive, would bear roughly the same size relationship to Mt. Everest as a molecule of silica sand would to a grain of sand $\frac{1}{16}$" diameter. Thus, to effect solution of the silica grains, a coating of the solvent (soda plus lime or soda, plus lime, plus silica) must coat or contact the surface of the silica grain. Then the saturated solution thus obtained must be removed and another fresh layer of solvent replace it and the operation repeated.

A grain of sand $\frac{1}{16}$" in diameter would have 2,190,000 layers of molecules, each layer of which would have to be washed away and replaced by another layer of solvent 2,190,000 times before complete solution of the silica

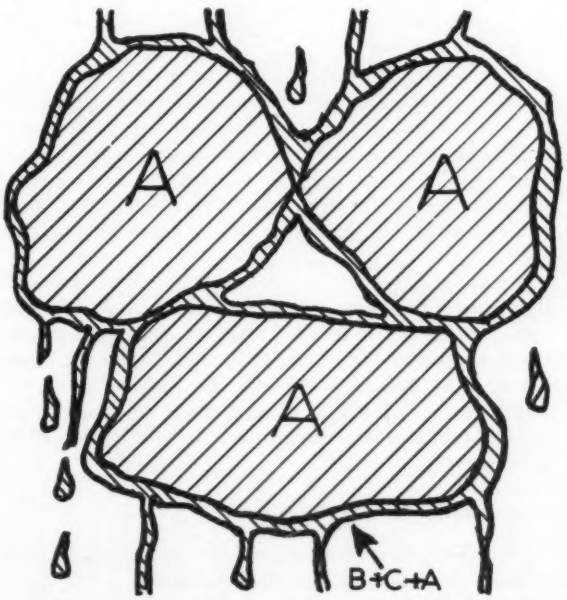


FIG. 10

is completed. This washing away and replacing is not a chemical matter but a mechanical one. For speed and efficiency it is necessary that there be a relative movement between the liquid solvent and the solid silica grain, otherwise the phenomena of solution would cease.

In the proposed erosion furnace, radiation, conduction and convection would have nearly ideal conditions. The glass would be in a thin coating on the lumps and would drop by gravity through the interstitial spaces in drops or strings, competely surrounded by the heating flames.

The relative movement between the practically stationary lumps and the moving liquid would be definite, rapid and controllable. The agitation, boiling, gas expulsion, etc., would take place in the upper portion of the shaft and as these turbulent factors became completed and the glass plained, there would remain only the progressively slower addition of the desired silica by molecular contact and fluid travel.

Molecules would be absorbed in solution, not grains of sand to be carried into the plaining end as is the case of the conventional melting method. Just what size ganister lumps, what temperatures would be desirable, what percentages of solvent would be incorporated into the briquettes and what percentage should be left for addition by erosion for the best results would be under factors of control by design and operation, and would have to be determined by certain research data not now available, and by actual experimental and commercial trials.

Attention is directed to certain factors of control. First, Chemical Proportions: Glass lacking in solvents at any given temperature is higher in viscosity than glass with a relative higher proportion of solvents. (This would decrease the rate of travel and absorption and automatically tend to equalize other portions having a higher proportion of solvents whose factors would tend to increase rate of travel and absorption.)

Second, Combustion and Flame Mixture: Just as convection currents in the tank body of glass tend to travel in parallel positions and do a minimum of mixing, so the large volumes of fuel and air tend to avoid the desired intermingling.

In the shaft erosion furnace, the materials of combustion travel through interrupted spaces and impinge on one another and the glass materials causing a desirable combustion condition and eliminating the necessity for a large additional supply of air to complete the fuel combustion. The interrupted travel also allows better control and reduction in area of the desired temperature zones.

The flame travel rate is more uniform over the section of furnace. The temperatures in contact with the glass making materials is relatively higher, and the temperature is absolutely higher due to the small amount of heat extracted by radiation through the outside walls. A simple design enables the control travel and the various zones for the different stages occurring during the glass melting cycle.

Conclusions

First, the earlier chapters show the poor application of engineering to the glass melting problem.

Second, this poor engineering in turn prevents the best control of operations.

Third, it obviously necessitates resort to compromises in the quality of product.

Fourth, it is high in costs of installation, repairs, depreciation and fuel.

Fifth, the basic idea of maintaining the homogeneity of initial batch mixture is lacking in adequate controls.

Sixth, a basic change in the method to what may be termed the erosion method provides potential opportunity for the elimination or reduction of most of the evils of the conventional method.

Seventh, it provides a vastly wider range for engineering design.

Eighth, it likewise provides for a wider latitude in operation.

The author would warn any readers who may be interested in this general presentation that the object is to present a set of principles and functions for a better glass melting method. In its present form, it is intended to arouse the need for some way to break the present stalemate in melting progress by stimulating thought, inducing further discussion of the subject and further inquiry. It does *not* and is *not intended* to be a final answer to the problem. The illustrations are definitely *not intended* as adequate or final engineering designs. The sketches are mainly illustrations to clarify the principles presented.

The author hopes that this presentation will arouse sufficient interest to show that there are possibilities for a better approach to this subject than the conventional one. Criticism of any proposed changes is just as legitimate as criticism of any traditional and historical system like the present conventional method and structure. The outstanding difference is that one is fixed and the other fluid.

It is the author's opinion that this fixed idea more than any other single factor accounts for lack of progress. History and tradition have very little value in this connection at least to the extent that they have and continue to have the important role they now possess.

It has been my privilege to have taken an active part in the development of the automatic feeder, the automatic window glass method, the modern annealing of plate glass, window glass, and containers, and the modern container and bulb making process over a period when these developments broke away from the traditional methods and into the present greatly improved methods.

Based on this background, it is the author's conviction that the tank problem, while admittedly involving difficulties, is no greater than those of the other departments of glass making whose problems have been met and overcome.

A.C.S. 51st ANNUAL MEETING TO BE HELD IN APRIL

Announcement has been made that the 51st Annual Meeting of the American Ceramic Society will be held in Cincinnati, Ohio, on April 24 through 28, 1949.

The Society has announced that this year there will be three participating hotels for the meeting. The Glass Division meetings will be held in the Gibson Hotel, the Refractories Division meetings will be held in the Sinton Hotel and the meeting place for the rest of the Divisions will be the Netherland Plaza. All general meetings, registration and general entertainment will be held in the Netherland Plaza Hotel.

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Glass Compositions

Corning Ophthalmic Glass. Patent No. Reissue 23,049. The original patent for this glass composition was No. 2,433,883, dated Jan. 6, 1948. The application for the reissue was filed Feb. 11, 1948. It is the invention of William H. Armistead who assigned it to Corning Glass Works.

This composition relates to a glass for sealing into an optical crown glass to make multifocal spectacle lenses which many of us wear and call bifocals. The requirements for a glass of this kind are very exacting not only for optical reasons but also for mechanical reasons brought about by the requirements for sealing to another glass.

The following six examples of batches calculated in weight percentage illustrate the invention, compositions 5 and 6 being particularly suited for use with optical crown glass in the manufacture of bifocal lenses:

	1	2	3	4	5	6
SiO_2	50.9	50.9	50	47.5	44.5	37.5
B_2O_3	6	4	2	4	4	4
XrO_2	10.2	10.2	10	8	7	5.5
BaO	10	12	.....	18	20	20
ZnO	12	10	12	5	7.5	10
Li_2O	2.8	3	2	2	2	2
Na_2O	8.1	7.9	12	7.5	6.0	4.5
Al_2O_3	.....	2	2	2	2	2
CaO	.....	.....	10	5	5	10
TiO_2	.....	.....	.....	1	2	4.5
Softening Point, °C	650	664	675	666	667	662
Exp. Coeff. $\times 10^7$	.....	83.3	88.8	88.3	86.4	90
nD	1.5880	1.5882	1.5900	1.6051	1.6163	1.6537
v	53.3	53.2	52.1	52.2	50.6	46.1

No references were cited by the Patent Office during the prosecution of this application.

Metal Sealing Glass. Fig. 1. Patent No. 2,454,607. This is the invention of Charles E. Leberknight and Eugene C. Ostrander, who assigned it to Kopp Glass, Inc., of Swissvale, Pa. The invention relates particularly to use with iron-nickel alloy having a composition of about 42% nickel and 58% iron. This is characterized by a sharp break in its cooling or expansion curve at about 400°C. Lead-free glass is best for such use. A glass having a high B_2O_3 content has proved to be unsatisfactory.

Fig. 1 shows two curves plotted in accordance with the standard procedure $\frac{\Delta L}{L}$ taken at the cooling rate of 1°C. per minute. The plotted curve G shows the characteristics of a glass having about the following composition:

	Per Cent
B_2O_3	22
Al_2O_3	5
TiO_2	3
ZrO_2	1
SiO_2	58
Na_2O	5
K_2O	3
Li_2O	3

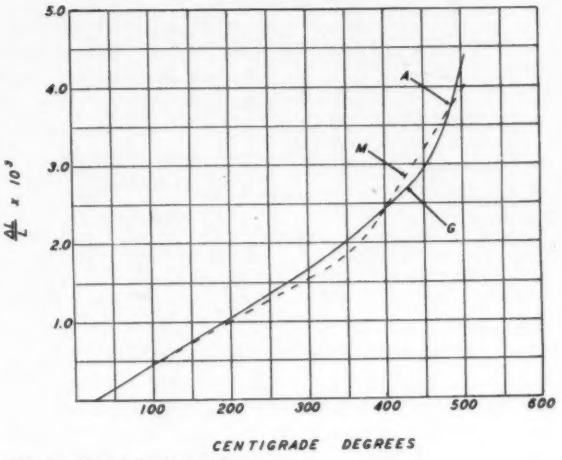


Fig. 1. Metal Sealing Glass.

The curve M is plotted from a glass composition about as follows:

B_2O_3	20% to 24%
Al_2O_3	3% to 6%
TiO_2	2% to 5%
ZrO_2	.5% to 1.5%
Na_2O, K_2O	Not less than 2% of each of these alkali metal oxides
Li_2O	7% to 12%
SiO_2	56% to 68%

The following references are of record in the file of this patent: United States Patents: 1,394,296, Fisher, Oct. 18, 1921, and 1,557,540, Horak, Oct. 13, 1925.

Fluoborate Glass. Fig. 2. Patent No. 2,456,033. Kuan-Han Sun assigned this patent to Eastman Kodak Company. The new glass has characteristics making it particularly desirable for optical use.

Fig. 2 shows a ternary diagram setting out the region of glass formation of the system exemplified in the following table in both weight and "cationic" or "mole" per cent, the former being shown in a solid line and the latter in a broken line. These boundary lines are arbitrary because glass formation is a function of experimental conditions, such as the size of the melt, rate of cooling, shape of the vessel and of the mold, temperatures of the melt during pouring, and temperature of the mold, but they serve to indicate the general region as observed experimentally.

Example	CaF_2		$LaO_{1.5}$		$BO_{1.5}$		F/B	nD	v
II-1	3	2.6	59	24.3	38	73.2	0.07	1.7265	54.8
II-2	11	10.5	60	27.4	29	62.1	0.34	1.7191	55.6
II-3	16	14.7	54	23.7	30	61.6	0.48	1.6955	57.4
II-4	22	19.3	47	19.7	31	61.0	0.63	1.6540	61.0
II-5	23	20.1	46	19.2	31	60.7	0.66	1.6637	59.5
II-6	23	21.4	50	22.3	27	56.3	0.76	1.6759	58.0
II-7	24	21.5	47	20.2	29	58.3	0.74	1.6823	56.9
II-8	24	23.3	52	24.3	24	52.4	0.89	1.711	56.5
II-9	25	20.4	40	15.7	35	64.0	0.64	1.636	63.0
II-10 ...	30	23.9	35	13.4	35	62.7	0.76	1.6394	61.6
II-11 ...	40	26.0	12	3.8	48	70.2	0.74	1.6043	64.5

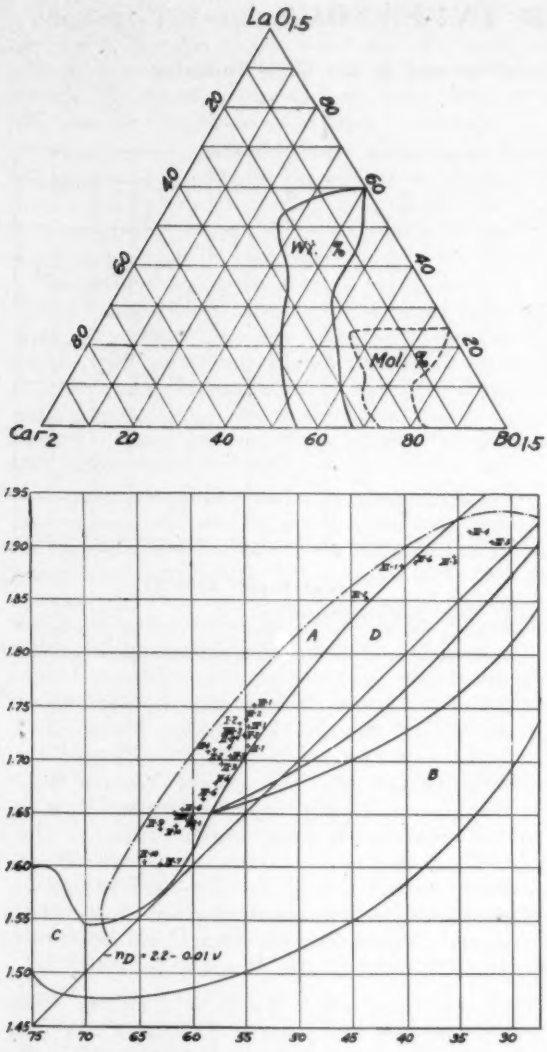


Fig. 2. Fluoborate Glass.

The figure also shows a chart on which the refractive index n_D is plotted against Abbe value ν. This chart discloses numerous compositions besides those shown in the preceding table but which can be found in the patent. They all fall within the region A. Common commercial glass comes within the area B, fluophosphate glasses in area C and rare-element borate glasses in D. The patent should be studied for many examples and detailed information.

The following references are of record in the file of this patent: United States Patents: Re. 13,766, Macbeth, July 7, 1914; 1,143,788, Schnelbach, June 22, 1915; 1,327,569, Peregrine, Jan. 6, 1920; 1,529,259, Locke et al., Mar. 10, 1925; 1,623,301, Brenner, Apr. 5, 1927; 1,971,309, Fuwa, Aug. 21, 1934; 2,056,627, Smelt, Oct. 6, 1936; 2,255,109, Fischer, Sept. 9, 1941; 2,262,951, Lyle, Nov. 18, 1941; 2,269,176, Booth et al., Jan. 6, 1942; 2,272,747, Hull et al., Feb. 10, 1942; 2,282,601, Blaw, May 12, 1942; 2,334,961, Schoenlaub, Nov. 23, 1943; 2,393,449, Armistead, Jan. 22, 1946; 2,394,502, Weyl et al., Feb. 5, 1946; and 2,397,195, Mook et al., Mar. 26, 1946. Foreign: 8,704, Great Britain, 1907, and 492,960, Great Britain, 1938. Other References: Ser. No. 395,364, Berger et al. (A. P. C.), pub. May 11, 1943.

Glass Wool and Fiber

Method and Apparatus for Making Glass Fibers. Fig. 3. Patents Nos. 2,455,907 and 2,455,908. These two patents were assigned to Owens-Corning Fiberglas Corporation by Games Slayter. One of these patents shows a melting apparatus and the other a method of making glass fibers employing the same melter so that it is convenient to consider the patents together. The latter patent resulted from a division of the earlier application.

It has formerly been necessary to maintain a large volume of molten glass under a high temperature for a long time in order to obtain the required supply of refined molten glass. This invention makes it possible to melt dry batch continuously and to reduce it practically instantaneously to a molten and refined state. A positive pressure is maintained on the glass in the matter which results in the continuous discharge of glass as soon as it reaches a fluid state. Some features of the invention may be useful in glass melting for other purposes than making glass fibers.

Fig. 3 shows a section through the melter or furnace and the furnace as arranged with a forehearth. The melter 9 comprises a metal casing 10 having a refractory lining 11 forming a chamber 12. The melter is mounted on a frame S and has a discharge opening 14 at the lower end. The chamber is heated by burners 17 mounted tangentially so as to produce a swirling action in the chamber, the products of combustion passing out through the opening 14. The sting-out from the opening may be employed to form fibers at that point or to heat a refining chamber or forehearth 35.

The batch is delivered to the chamber 12 through a chute 18 fed by a hopper 19 by means of a feed screw 20 and a motor 21. A distributator 22 at the lower end of the chute 18 causes the batch to be deflected laterally

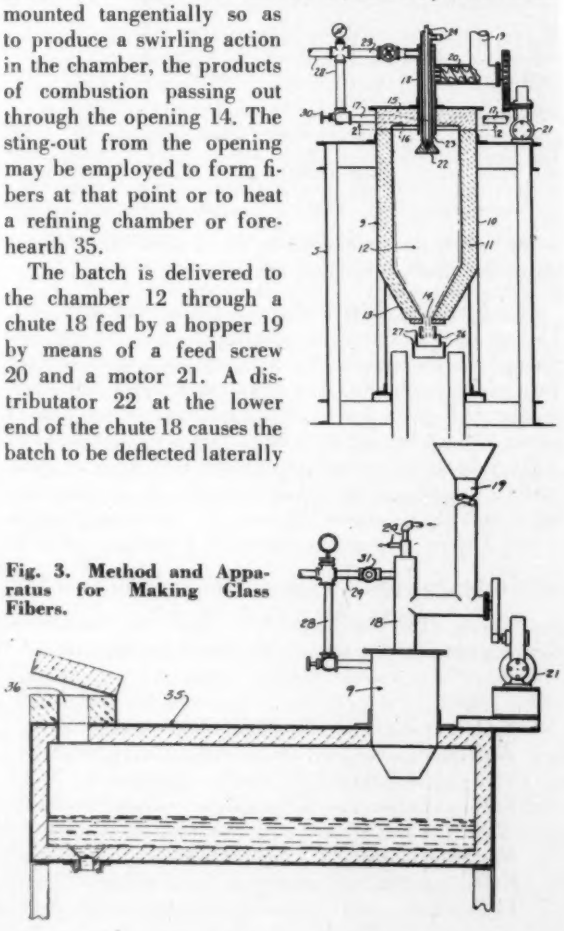


Fig. 3. Method and Apparatus for Making Glass Fibers.

toward the sides of the chamber 12 where it is melted at once. The chamber is maintained under a positive pressure and in order to restrain the issuing fibers from spreading out, concentric tubes 26 may be provided.

When this melter is to be employed in connection with a forehearth, the tubes 26 may be omitted. The molten glass is delivered forceably into the forehearth 35 which has the usual stack 36 and an orifice for the delivery of a continuous flow of molten glass. A series of melters are suggested for cooperation with a single forehearth.

The following references are of record in the file of Patent No. 2,455,907: United States Patents. Re. 20,282, Powell, Aug. 16, 1938; 1,371,084, Ferguson, Mar. 8, 1921; 1,500,651, Smith, July 8, 1924; 1,756,381, Pahl, Apr. 29, 1930; 1,769,181, Jackson, July 1, 1930; 1,964,915, Haswell et al., July 3, 1934; 2,006,947, Ferguson, July 2, 1935; 2,038,251, Vogt, Apr. 21, 1936; 2,131,599, Shrum, Sept. 27, 1938; 2,165,242, Drill, July 11, 1939; 2,212,448, Modigliani, Aug. 20, 1940; 2,268,546, Forter, Jan. 6, 1942; and 2,331,944, Von Pazsiczky et al., Oct. 19, 1943. Foreign Patents: 57,227, Norway, Oct. 25, 1936; 551,272, Germany, May 28, 1932; 651,687, Germany, Oct. 18, 1937; 780,140, France, Jan. 24, 1935.

The references in the file of Patent No. 2,455,908 are: United States Patents: 779,307, Parkison, Jan. 3, 1905, and 2,165,242, Drill, July 11, 1939.

Miscellaneous Processes

Machine for Sealing Radio Tubes. Fig. 4. Patent No. 2,455,317. This patent was assigned to National Union Radio Corporation by Gerhard G. Schneider of Maplewood, N. J. Certain radio tubes have pins extending through both the top and the bottom of the tube and heretofore this has required separate operations. This machine makes all the seals at the same time and in a proper manner.

Fig. 4 is a section through the machine which comprises an intermittently moving table 2 mounter for rotation on a base 1. There are 12 tube holders or heads 3, these heads being separated by fire resistant partitions 5 so that the heat from burners 4 and 4a and 4b will be confined to the desired tube. Fuel for the burners is supplied from a manifold 6.

Each head 3 is fixed on a shaft 10, the lower end of which carries a pulley 11, a gear 12 and an arm 13 having a depending pin 14 which controls the rotation of a ceramic tube-receptacle 19 which supports the lower end of the tube to be sealed. The upper end of the tube is positioned by a device carried on a bar 24 having one end pivoted on an upright 22 and the other latched to a similar upright 23. The arrangement is such that the tube is positioned between the members 42 and 44 and the member 19. A conduit 50 is connected to a chamber 51 having a supply of inert gas.

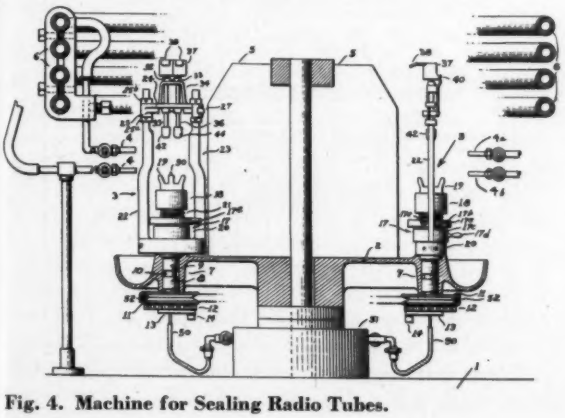


Fig. 4. Machine for Sealing Radio Tubes.

The heads 3 are rotated at the proper times by a belt 52 driven by a suitable motor. The pin 14 serves to stop the rotation and hold the head in the desired position at certain stations. At the proper time the gear 12 engages a driving gear to rotate the parts. The pin 14 holds the parts in fixed position when necessary.

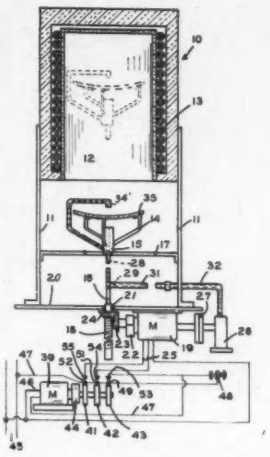


Fig. 5. Glass Tempering Machine.

The following references are of record in the file of this patent: United States Patents: 1,569,185, Higgins, Jan. 12, 1926; 1,742,153, Stiles et al., Dec. 31, 1929; 2,023,628, Van Sant, Dec. 10, 1935; 2,063,235, Eisler, Dec. 8, 1936; 2,079,893, Bain et al., May 11, 1937; 2,162,209, Trutner, June 13, 1939; 2,185,704, Donovan et al., Jan. 2, 1940; 2,267,598, Thomas, Dec. 23, 1941; 2,322,728, Gates, June 22, 1943; 2,334,001, Hapgood, Nov. 9, 1943; and 2,376,540, Iden, May 22, 1945.

Glass Tempering Machine. Fig. 5. Patent No. 2,455,085. This machine is the invention of Charles D. Oughton, Scott Sterling and Arthur F. Turner, who assigned it to Bausch & Lomb Optical Company. The patent relates particularly to the manufacture of safety goggles and prescription ground lenses and it provides a machine which can be used by opticians for tempering lenses which they have ground.

The device seen in the drawing comprises a furnace 10 having a chamber 12 furnished with a heating unit 13. The bottom of the chamber is open so as to permit the entrance of a lens carrying support in the form of fingers 14 projecting from a cap 15 detachably mounted on the top of a vertically movable shaft 16. This shaft is raised and lowered by a motor 19 which drives a bevel gear 23 in mesh with a second gear 24 which is threaded onto a shaft 18. The rotation of the motor 19 is reversible so that the shaft 16 can be raised and lowered. The motor also drives an air compressor 26 connected to a nozzle 34' arranged to discharge a blast of air against the lens 35 but this is controlled so that the blast is delivered only when the lens carrier is moving downwardly out of the furnace. Air is also delivered upwardly against the under side of the lens, from an opening in the top of the cap 15.

All the movements are automatically controlled by cams 41, 42 and 43 driven by a motor 29 and acting to open and close a series of switches. These cams may be adjusted to give the proper treatment to the lens as determined by the character of the glass, temperature of the furnace and other factors.

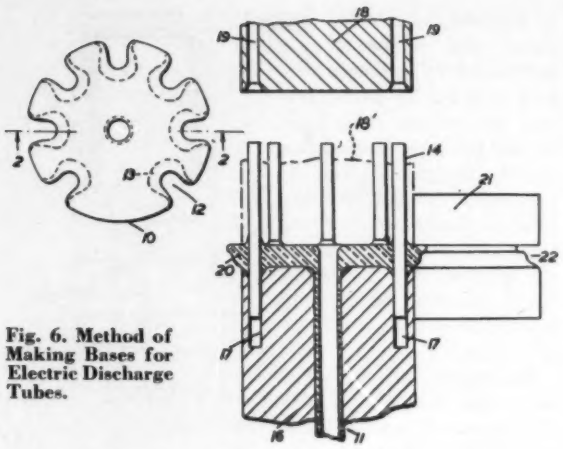


Fig. 6. Method of Making Bases for Electric Discharge Tubes.

The following references are of record in the file of this patent: United States Patents: 1,809,534, Tillyer et al., June 9, 1931; 2,054,595, Clitherow, Sept. 15, 1936; 2,111,370, Owen, Mar. 15, 1938; 2,144,320, Bailey, Jan. 17, 1939; 2,166,348, Ford, Jr., July 18, 1939; and 2,269,-060, Mitford, Jan. 6, 1942. Foreign Patents: 505,188, Great Britain, May 5, 1939, and 616,445, Germany, July 29, 1935.

Protection of Glass Surfaces. Patent No. 2,454,886. This patent does not relate directly to the manufacture of glass but rather to the protection of the surface of glass from moisture, condensation, frost or anything that would impair visibility. It is the invention of Reuben H. Sapiro of Pinner, England.

One example of a new mixture for holding a flexible sheet to a glass surface is:

Gelatin	gms.	40
Nitro-cellulose	gms.	1–5
Glacial acetic acid	cc.	250–400
Sodium choleate	gms.	10–15
Water	cc.	100–150
Industrial methylated spirit (64 O. P.)	cc.	600–750

A small amount, say 1 to 5 grams, of salicylic acid may be added for its preservative properties.

An example of the wetting and softening liquid used in the pretreatment of the sheet is:

Water	cc.	200
Glycerine	cc.	10–50
Sulphonated ester of oleic acid	cc.	1–20
Diethylene glycol monobutyl ether	cc.	1–20

This liquid may also be used as a reviver for the sheet after exposure has decreased its protective properties.

The following references are of record in the file of this patent: United States Patents: 2,368,583, Tage, Jan. 30, 1945; 2,313,570, Nadean et al., Mar. 9, 1943; 2,292,-097, Vollmer, Aug. 4, 1942; 2,139,866, Strouts, Dec. 13, 1938; 2,118,262, McGrady et al., May 24, 1938; 2,101,-472, Kormann, Dec. 7, 1937; 1,988,584, Dana et al., Jan. 22, 1935; 1,977,545, Elbel, Oct. 16, 1934; 1,943,268, Fleischer, Jan. 9, 1934; 1,900,540, Broderick, Mar. 7, 1933; 1,865,497, Atwood, July 5, 1932; 1,705,453, Demaret, Mar. 12, 1929; 1,466,888, Morrissey, Sept. 4, 1923; 1,369,708, Roberts, Feb. 22, 1921; and 1,213,368, Hibbert, Jan. 23, 1917. Foreign Patents: 320,374, Great Britain, Oct. 7, 1929; 2,694, Great Britain, 1887; and 300,681, Germany, Sept. 9, 1919.

Method of Making Bases for Electric Discharge Tubes. Fig. 6. Patent No. 2,454,834. This invention is applicable to the manufacture of various tubes such as cathode ray tubes, thermionic valves, etc. It is the invention of Stephen John Powers of London, England, who assigned it to International Standard Electric Corporation of New York. This invention makes a base by placing the wires in radial slots formed in the periphery of a glass disc and then rolling the edge of the disc by means of suitable tools, to mold the sides of the slots firmly around the wires.

Fig. 6 shows a circular disc 10 having a number of slots 12 around its periphery and an exhaust tube 11. The disc 10 is placed on the lower die 16 which has a number of holes 17 to support the wires 14 in proper position to cooperate with the slots 12. The wires have beads previously fused to them in position to contact with the sides of the slots. After the glass disc has been heated to the softening point, the upper die 18, which has holes 19 to receive the wires 14, is lowered into the position shown in dotted lines at 18'. A roller tool 21 having a formed edge 22 runs around the edge of the disc to form a bead 20. This closes the slots firmly around the wires and seals the disc to the bead previously formed on

(*Continued on page* 50)

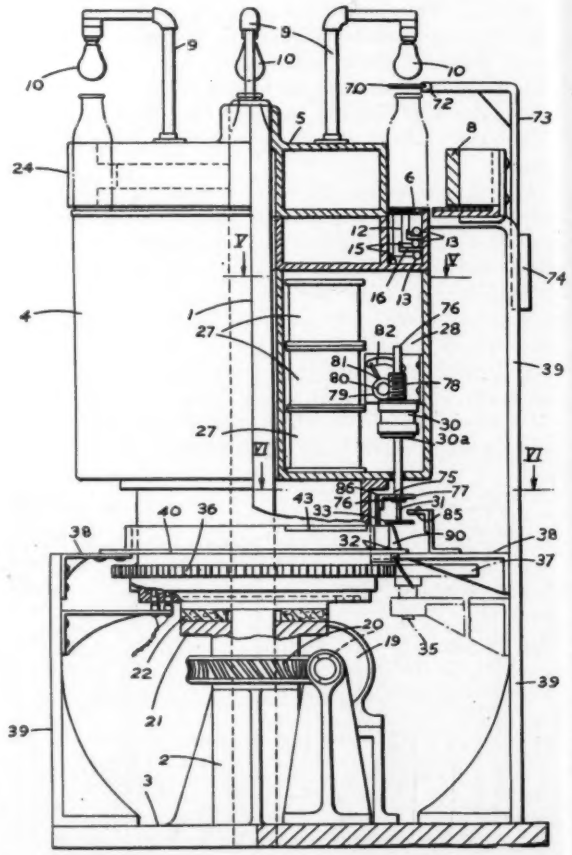


Fig. 7. Inspection Apparatus for Milk Bottles.

Research Digest

The Effect of Low Temperatures on the Breaking Strength of Sheet Glass

The determination of the effect of temperature on the mechanical strength of glass serves two useful purposes, one of which is theoretical while the other is practical. The theoretical purpose concerns itself with the answer as to whether or not mechanical strength is a chemical process or is influenced by chemical processes. It is well known that in general chemical processes are influenced by temperature. If it can be shown that the mechanical strength of glass varies with temperature, the indications are that some sort of chemical process may be involved. On the practical side, glass is now utilized under various temperature conditions ranging from below 0°C. in the case of aircraft windshields to over 100°C. in the case of glass piping and the like. A knowledge of the effect of temperature on the breaking strength is therefore necessary for successful application.

Very few data have been published on the effect of low temperature on the strength of glass. K. Mengelkoch has made determinations in the temperature range —190° to 500° on a small number of samples. A. Smekal, using loading rates of 420 and 53g. per sq. mm. per sec., has made tensile strength measurements in the temperature range —190° to 520°, while F. W. Preston measured the breaking strength in the range —200° to 500°. G. O. Jones and W. E. S. Turner have reported on the modulus of rupture of glass in the temperature range 20° to 534°. A. J. Holland has recently extended their work to levels below room temperatures and has described his experimental methods and reported his results in the February, 1948 issue of *The Journal of the Society of Glass Technology*.

The specimens for test were cut from 24 in. by 24 in. squares of 21 oz. flat-drawn sheet glass, the first step being the cutting of 12 in. by 5 in. strips which were then annealed. From these annealed strips, smaller strips (6 cm. by 0.8 cm.) were then cut and cemented into blocks which were mechanically ground and polished on all of the edges. The polished blocks were then separated into individual pieces and all imperfect specimens discarded. A part of the mechanically ground and polished was then fire-polished which process effectively sealed all flaws which may have remained in the edges. The fire-polished specimens were then reannealed. The two groups of specimens were packed into groups of ten each using random selection.

In the case of the mechanically ground and polished specimens, the modulus of rupture was determined at 17.5° (total tested = 150) and at —40° (total tested = 130), the maximum, minimum, average and the per cent coefficient of variation being reported. The data was also reported in the form of frequency curves. The effect on the modulus of rupture of decreasing the temperature from 17.5° to —40° has been to increase the strength from 10.1 to 12.6 kg./mm.^{2}, an increase of 25 per cent. This increase, as shown by a comparison of the two frequency curves, has been brought about by an increase in the strength of the glass as a whole and not merely by the elimination of weak specimens and the increase in strength of a small number only.

Similar determinations were made on the specimens having their edges fire-finished after being mechanically ground and polished and an additional determination was made at —20°. Decreasing the temperature from 17.5° to —40° has resulted in this case in an increase in the modulus of rupture from 21.4 to 25.4 kg./mm.^{2}, an increase of approximately 20 per cent. At —20°, the modulus of rupture, 22.9 kg./mm.^{2}, fell between the values obtained at room temperature and at —40°.

In the investigation on the effect of temperature on the impact strength of glass, 4 in. by 4 in. specimens were cut from the 21 oz. flat-drawn sheet glass by following an alphabetical and numerical procedure. Part of the specimens were reannealed. Specimens with odd numbers were tested at room temperature, specimens with even numbers were tested at —40° using a pendulum (500g. weight and 10 in. length) type impact apparatus.

In the case of the reannealed specimens, 50 samples were tested at 17.5° and 50 samples were tested at —40°. The data reported included the maximum, minimum and the average height (cm.) required to cause fracture and the per cent coefficient of variation. The data was also presented in the form of frequency curves. A reduction in temperature from 17.5° to —40° was accompanied by an increase in the height necessary to cause fracture from 17.1 to 20.6 cm. The type of fracture and the distribution of the results were similar in both tests. In all cases, the fracture appeared to have started close to the impact point but on the surface remote from the impact. As is usual, the complexity of the fracture increased with the strength of the blow needed to cause fractures.

The "commercially annealed" specimens showed a tensile stress of 12 kg. per sq. cm. at the center and a compressive stress of 32 kg. per sq. cm. at the surface and, as a result, showed higher impact strength values. Decreasing the temperature from 16° to —40° increased the height of fall necessary to cause fracture from 18.7 to 21.9 cm., an increase of 17 per cent. Again, this was brought about by a general increase of the strength and not by the inclusion of a few specimens giving abnormally high levels.

The increase in the mechanical strength of glass brought about by lowering the temperature of test is of the same order as that found by F. W. Preston and by A. Smekal, respectively, for the same temperature range.

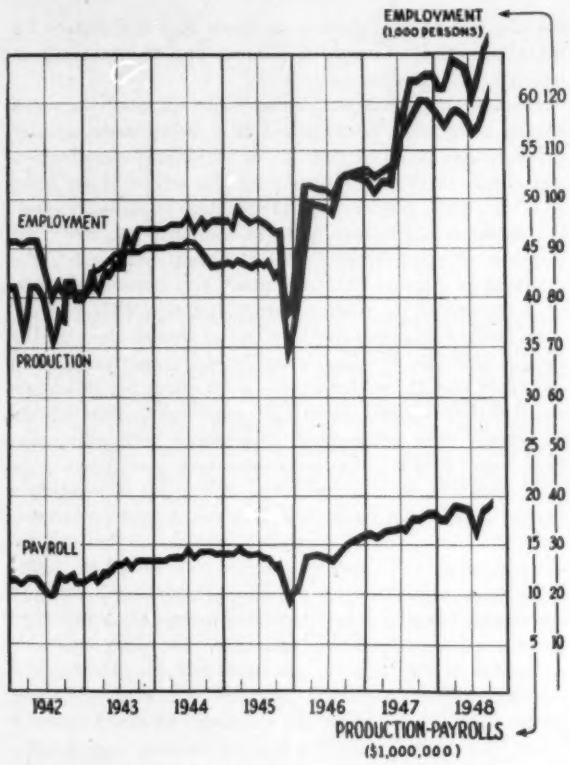
A Study of Some Special U.V.-Absorbing Glasses Which Are Transparent to Visible Radiation

Glasses, which are transparent to visible radiation and opaque to the ultraviolet and which are colorless or nearly so, find a field of use in those cases where it is desired to protect materials from the harmful effects of

(*Continued on page* 58)

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX



Activity in the glass industry as shown by the Production Index for the month of October 1948 has risen to an estimated total of $71,500,000. This figure represents a gain of 7 per cent over the previous month's estimate of $67,000,000. During October 1947, production was an approximate $63,500,000, or 12 per cent below October this year. Total estimated production during the January-October 1948 period has reached $640,800,000, as compared with $591,500,000 reported at the close of the same period in 1947—a difference of about 8 per cent.

Employment and payrolls: During the month of October 1948, employment was reported to be 123,200. During the month of September, employment had been 118,600, which is about 3 per cent below October. During the month of October 1947, employment was 119,700.

Payrolls for the month of October 1948 rose about 7 per cent to an estimated $19,750,000 over the previous month's estimated $18,500,000. During October 1947, payrolls were estimated to be $18,000,000, which is 9 per cent below October this year. Glass manufacturers paid out an estimated $170,000,000 during the first ten months of 1948, as compared with $166,500,000 at the close of the corresponding months in 1947.

Glass container production, based on figures released by the Bureau of Census, dropped sharply to 7,312,507 gross for the month of November 1948. This is 19 per cent below the previous month's total of 9,107,323 gross. During November 1947, production was reported to be 8,429,525 gross, which is about 13 per cent above November this year. Total glass container production for the first eleven months of 1948 has reached 91,997,844 gross, as compared with 107,336,245 gross produced during the corresponding period in 1947.

Shipments for the month of November also dropped sharply to 6,709,729 gross. This is 20 per cent below October's shipments of 8,457,337 gross. During November 1947, shipments were 8,113,222 gross, or 17 per cent above November 1947. Glass container shipments during the January-November 1948 period have reached

(*Continued on page* 44)

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	November 1948
Narrow Neck Containers	
Foods	559,953
Medicinal & Health Supplies	875,879
Chemical, Household & Industrials	394,788
Beverages, Returnable	248,382
Beverages, Non-returnable	.....
Beer, Returnable	106,184
Beer, Non-returnable	228,245
Liquors	949,010
Wines	315,612
Toiletries & Cosmetics	379,366
Sub-total (Narrow)	4,057,419
Wide Mouth Containers	
Foods	1,718,182
Dairy Products	298,688
Home Canning	*3,347
Medicinal & Health Supplies	262,899
Chemical, Household & Industrials	59,194
Toiletries & Cosmetics	77,016
Packers' Tumblers	86,539
Sub-total (Wide)	2,505,865
Total Domestic	6,563,284
Export Shipments	146,445
Total Shipments	6,709,729

*This figure represents Fruit Jars only.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production November 1948	Stocks November 1948
Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries and Cosmetics	Narrow Neck	2,496,096	2,924,588
	Wide Mouth	2,352,484	1,925,405
Dairy Products		313,682	213,922
Home Canning		.....	658,154
Beverages, Returnable		293,190	645,890
Beverages, Non-returnable		.....	.....
Beer, Returnable		141,394	729,171
Beer, Non-returnable		257,132	330,333
Liquors		1,034,609	546,393
Wines		331,556	230,449
Packers' Tumblers		92,364	76,472
Total		7,312,507	8,280,777

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In the prize ring it takes a good fighter who can throw solid punches with both fists to rise to the top in his class. He needs both hands to do the job.

The "pug" who is good with only his right or his left is generally in for trouble when he faces a worthy opponent.

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TECO DUAL FIRING provides positive reliability with a quick, easy change-over from gas to oil or vice versa. Burners and burner blocks are uncommonly accessible.

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HARTFORD-EMPIRE COMPANY

HARTFORD 2, CONNECTICUT

CURRENT STATISTICS . . .

(*Continued from page* 42)

a total of 90,906,836 gross, as compared with 102,437,010 gross.

Stocks on hand at the close of November 1948 have risen somewhat to 8,280,777 gross, as compared with 7,794,565 gross on hand at the close of October. Stocks at the close of November 1947 were 8,116,577 gross.

Automatic tumbler production fell off a little more than 6 per cent for the month of November 1948 to 5,495,835 dozens, as compared with the previous month's production of 5,851,555 dozens. Production during November 1947 was 4,674,276 dozens. Shipments for November 1948 dropped close to 12 per cent and were 4,792,248 dozens. During October 1948, they were 5,428,811 dozens. Shipments for November 1947 were 4,960,569 dozens. Stocks on hand at the close of November 1948 were 7,841,083 dozens, or close to 10 per cent above October's 7,150,161 dozens. Stocks at the close of November 1947 were 8,694,157 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware for the month of November 1948 were 3,204,900 dozens. This figure represents a sharp decline of 25½ per cent from the previous month's sales of 4,300,699 dozens. Sales during November 1947 were 4,180,884 dozens. At the close of the 12-month period ending November 1948, manufacturers' sales had reached a total of 41,663,127 dozens, as compared with 41,232,723 dozens sold at the close of the corresponding period in 1947.

The figures for automatic tumbler production and sales of table, kitchen and household glassware of one manufacturer are estimated due to this company's inability to meet THE GLASS INDUSTRY's deadline. However, the totals for this concern have been estimated in order to complete the compilation of total industry figures. These total figures will be adjusted in the next issue of THE GLASS INDUSTRY.

SCIENTIFIC AND TECHNICAL BRITISH PUBLICATIONS AVAILABLE

A special list of recent scientific and technical publications of British government agencies has just been compiled by and are available through the Office of Technical Services of the Department of Commerce.

Items listed include a description of the manufacture of hand-blown glassware, flameproof testing methods, aluminum and aluminum alloys for food machinery, etc.

Through a reciprocal arrangement that has been in operation for several years, the Office of Technical Services is regularly informed of new scientific and technical publications of the British government. A copy of the free list on these publications may be obtained by addressing the Reference Service, Office of Technical Services, Department of Commerce, Washington 25, D. C.

• Morton S. Cressy, formerly head of the Hartford-Empire Company's glass plant engineering department, has been named General Manager of the company's sales and service.

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Fig. 1 – Air Heater.

AVOID CRITICAL GAS SHORTAGES

Many industrial ovens, furnaces and boilers are fired with gas burners which do not lend themselves to the substitution of direct oil burners during the trying days of gas curtailments. For such applications North American offers the Oiltogas Converter.

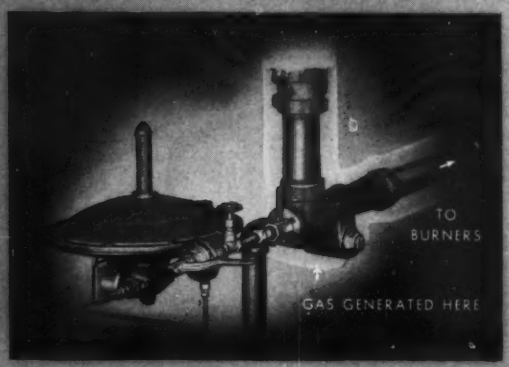

Fig. 2 – Insert Assembly and Mixer.

PRODUCES CLEAN CARBON-FREE GAS FIRES

The principle of the Oiltogas Converter is to supply air at 700°F. to standard North American Aspirator (Gas-Air) Mixers. Into the mixer (through the displacement rod) is injected atomized oil. The hot air immediately vaporizes all of the finely atomized oil and carries the gaseous fuel thus generated to any number of burners.

The air heater shown in Figure 1 is direct oil-fired and is entirely automatic in operation and includes flame safety devices. The amount of fire at the furnace or oven burners is controlled by valves in the hot air line leading to the mixers.

Because of the high air temperatures used and the excellent atomization of the fuel, it is found that even on #3 catalytic fuel oil no carbon or condensate is formed in the piping or burner manifolds. This eliminates the necessity for installing condensate return piping and for periodic cleaning.

*A combination of Standard Combustion Equipment, backed by 30 years of Dependable Service

THE NORTH AMERICAN MANUFACTURING COMPANY
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APPOINTMENTS IN CZECHOSLOVAK GLASS RESEARCH

According to an official statement of the Czech Glass Research Institute, news about recent appointments may be supplemented and corrected as follows:

Dr. V. Ctyroky, whose resignation as director of the Institute was announced by GLASS INDUSTRY, has been appointed in the District Management of the Slovakian Glass Works in Bratislava. His successor is Dr. O. Pridal, well known author of technical papers and a member of the Institute's staff for 19 years.

Dr. M. Fanderlik, Lecturer of Glass Technology at the Technical University at Brno, has been appointed Director of Glass Research and Development in charge of all existing glass research institutions, including two institutes and six industrial laboratories. He retains his academic function.

A.C.S. SECTION MEETINGS

The first meeting of the newly formed Tennessee Valley Section of the American Ceramic Society was attended by over 75 members. The charter for the new local Section was formally presented by Professor John W. Whittemore, President of the Society.

Officers elected at this meeting included Chairman, Emerson D. Poste, consulting engineer; Vice-Chairman, Kenneth G. Skinner, non-metals engineer, Bureau of Mines; Secretary, Murray A. Schwartz, ceramic engineer from the NEPA Project; Treasurer, G. J. Cahoon, Knox Porcelain Corp.; and Councillor, Hewitt Wilson, supervising engineer from the Bureau of Mines.

The Pittsburgh Section of the A.C.S. plans a meeting on January 14 at which Dr. H. C. O'Brien, Jr., Research Physicist at the University of Pittsburgh, will be speaker for the evening. Dr. O'Brien's subject will be "Applications of Electron Microscopy in Ceramics." A sound movie entitled, "The Mining, Milling and Smelting of Zinc," will also be shown.

At a recent meeting of the Trenton Section of the Society, Fred Whitaker, former counselor for that Section, addressed the meeting. Mr. Whitaker had just returned from a year's duty in Germany where he had been acting as coordinator for the ceramic industry in the American and British Sectors.

The American Ceramic Society's Northern Ohio Section presented as guests of the evening at its most recent meeting Mr. and Mrs. Giorgi of the Giorgi Potteries of Cleveland. After an extremely interesting talk and demonstration, a long question session was held with both Mr. and Mrs. Giorgi having numerous questions of all types asked them.

The Southern Ohio Section of the Society held its second dinner meeting of the season and presented C. A. Haffernon, Supervisor of Process Service of Linde Air Products Company. Mr. Haffernon spoke on "The Industrial Uses of Compressed Gases," and used slides and actual materials to illustrate his talk.

INNIS, SPEIDEN NAMES MANAGER OF NEW DEVELOPMENT DEPARTMENT

Paul W. Hiller, special representative for Innis, Speiden & Company, has been appointed Manager of the company's newly-formed Products Development Department.

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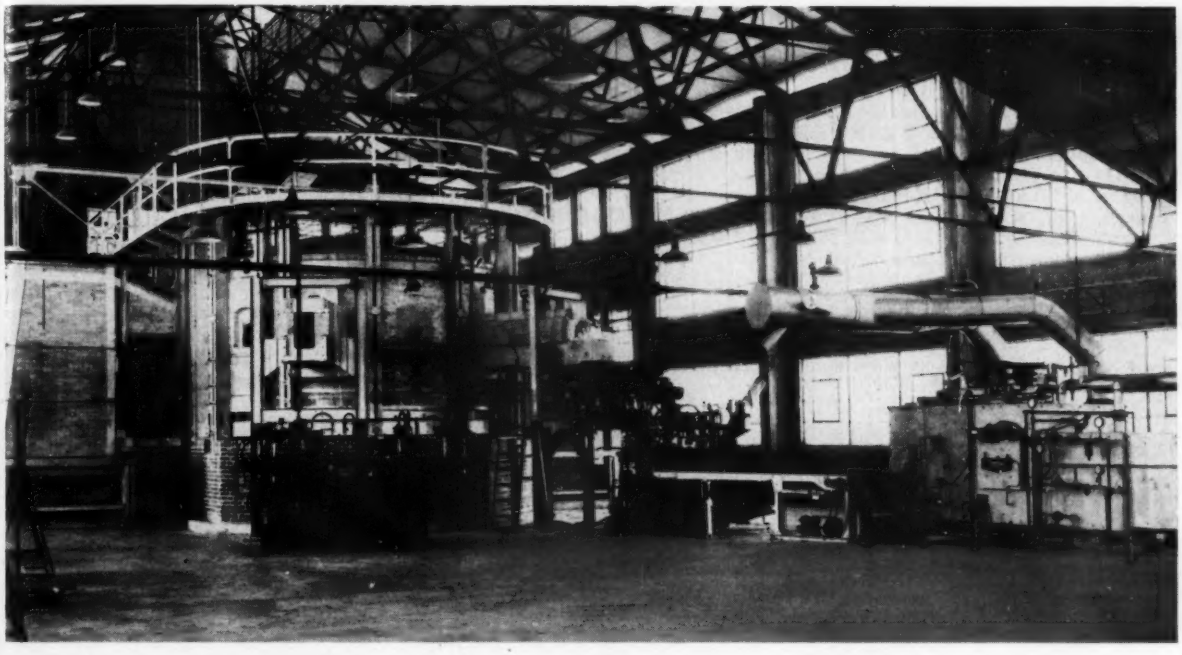

AMCO Installation During Construction Period . . .

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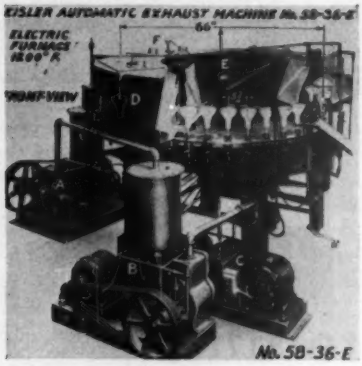
NEW EQUIPMENT AND SUPPLIES



EISLER AUTOMATIC EXHAUST MACHINE

Eisler Engineering Company, Inc., Newark 3, New Jersey, has announced the development of a new 36-head automatic exhaust machine adaptable for evacuating all types of bulbs up to 5½" in diameter, but especially designed for exhausting carbon lamps supposed to produce heat rather than light effect.

The machine illustrated is powered by a ¾ H.P., 1720 R.P.M. electric motor with variable speed pulley. The turret, mounted on a sturdy steel fabricated square table structure, is indexed by means of a large barrel-cam driving mechanism and carries a water-cooled circular manifold equipped with 36 compression rubber chucks into which the bulbs are successively inserted and clamped-in by the operator.

The loading of the chucks starts in the first two positions and is supported by the action of an adjustable bulb pusher which automatically pushes down the lamps to uniform height level. During the subsequent travel through the electrically heated furnace, each bulb is preliminarily evacuated between positions 3 to 23. Leak detector control is placed at position 4. From position 24 to position 33 inclusively, the bulbs, still within the oven, are further exhausted by two finishing high vacuum pumps. In position 34, the exhaust-tube of the bulb is automatically tipped off and the now finished bulb up to 3" in diameter is automatically discharged into the chute. Larger bulbs are manually loaded. Position 35 is blank.

In the last position 36, the remainder of the exhaust-tube is automatically pulled out by the tube puller and the continuously operating cycle of the machine starts again. The proper state of high vacuum is checked by means of a high frequency vacuum tester. The machine can be stopped instantly by means of a clutch actuated by a foot treadle. Production of the machine is from 350 to 600 per hour approximately, depending upon the size of the bulbs.

CRESCENT ELECTRIC INDUSTRIAL FORK TRUCKS

Crescent Truck Company, Lebanon, Pa., has announced the production of 3,000 and 4,000 pound electric industrial fork trucks equipped with pneumatic tires and an Automatic Self-Loading Scoop in capacities up to 15 cubic feet.

Described by the company as a fundamentally new design, the Automatic Self-Loading Scoop loads itself automatically when driven into a pile of loose material without the use of hydraulic cylinders or other auxiliary power.

An important advantage of the scoop, the manufacturer further states, is that it can self-load 100 per cent of capacity in loose materials and as much as 60 per cent in ceramic clay of high moisture content. When handling abrasive materials, Amsco edging and wear strips are provided on the bottom of the scoop.

Special controls simplify load release. Loads are released at any predetermined height by a fixed trigger or at any height within the lifting range of the truck by a manually operated lever.

EXTREME PRESSURE LUBRICANT

The Alpha Corporation, Greenwich, Conn., has announced a new type dry lubricant, "Molykote", which consists essentially of molybdenum disulphide powder and has the appearance of graphite though it contains none. With light rubbing, it adheres to even the smoothest surfaces.

Numerous tests, the company reports, have shown its extremely low friction co-efficient and unusual capacity to prevent galling or seizing at bearing pressures well over 100,000 PSI and at either high or low sliding velocities. Ten ounces will cover 500 square feet of smooth metal surface with a tenacious shiny coating. The lubricant is suggested for use as a factory-applied lifetime lubricant for mechanical articles, as well as for high, low or room temperatures.

Molykote lubricant is available in 10-ounce shaker top cans and may be mixed to a paste with SAE-10 motor oil.

CLIPPER IMPROVES MASONRY SAW MODELS

Clipper Manufacturing Company, 2800 Warwick, Kansas City 8, Missouri, has announced publication of literature, GI49, covering the results of continued research in its field.

The latest Clipper models in masonry cutting incorporate such production speed-up features as the "Adjust-A-Cut" control for instantaneous one-man adjustment of the cutting head; "streamlined" ball bearing conveyor cart, precision balanced and designed, with aluminum alloy castings which return the flow of water when cutting wet with the Model HD-49; and a new improved "Snap-on" blade guard cover. Three separate units, the cutting head assembly, the saw frame and conveyor cart (none weighing over 154 lbs.) help to make Clipper saws the most portable of any complete masonry cutting equipment, according to the company's release.

CATALOGUES RECEIVED

Libbey-Owens-Ford Glass Company, Toledo 3, Ohio, has issued a consumer booklet featuring "Mirropane," the company's line of transparent mirrors.

The four-page pamphlet illustrates various installations, as well as describing the type of mirror used, the particular advantages in each individual installation and the use of lighting in conjunction with the use of the transparent mirrors.

Walsh Refractories Corporation, Dept. M-1, 4070 N. First St., St. Louis 7, Missouri, has issued a bulletin entitled, "Here's Where Savings Begin", featuring High Temperature Bonding Mortar.

Appleman Art Glass Works, Bergenfield, New Jersey, has announced the publication of a guide to what it terms the 23 basic lighting fixtures of the home lighting business.

The booklet explains functional and decorative features of the Appleman fixtures and includes a brief discussion of shock-resistant, heat-resistant Temprex, the Duratuf glass.

Mills Alloys, Inc., 11320 South Alameda, Los Angeles, California, is distributing a new catalogue illustrating the complete series of super-titan blasting nozzles with its exclusive titan tungsten carbide liners and accessories.

Special booklets have also been prepared with information on the use of blasting nozzles in the following industries: glass and monument decorating, foundry and heat treating, building cleaning, railroad and shipyard maintenance and cleaning.

Cyclotherm Corporation, Department 75-R, 90 Broad Street, New York 4, New York, has published Bulletin P-1 which gives a complete description of the operating principles and design characteristics of Cyclotherm automatic steam generators.

Included in the bulletin are diagrammatic sketches of the cyclonic combustion operating principle, automatic firing sequence, electronic controls, flame characteristics, construction details, performance data and standard ratings for both steam and hot water generators in sizes from 10 to 300 H.P.

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CINCINNATI 23, OHIO

INVENTIONS AND INVENTORS . . .

(*Continued from page* 40)

the wire. The base thus formed is used in the same manner as has been usual.

The following references are of record in the file of this patent: United States Patents: 850,029, Meeker, Apr. 9, 1907; 872,530, Meeker, Dec. 3, 1907; 2,195,483, Franke, Apr. 2, 1940; 2,318,653, Wiener, May 11, 1943; 2,334,784, Miller, Nov. 23, 1943; 2,339,850, Goodale, Jan. 25, 1944; and 2,340,879, Horn, Feb. 8, 1944. Foreign Patents: 376,953, Italy, Dec. 1, 1939.

Inspection Apparatus for Milk Bottles. Fig. 7. Patent No. 2,454,411. This patent is the invention of Norman P. Stoate of Hampstead Garden Suburb, London, England. He assigned it to United Dairies Limited, also of London. While apparently the apparatus is designed particularly for use in a dairy to detect foreign bodies in the bottom of milk bottles, it would of necessity also detect foreign bodies in the glass itself and a lot of research has been conducted along this line in this country. Therefore, this patent and the one following of a similar nature, are worthy of a brief glance from the standpoint of the glass manufacturer.

The invention includes means for scanning the bottom of the bottle by means of a light directed into the mouth of the bottle, which passes through the bottom and onto a photo-electric device. A screen is positioned between the light and the photo-cells and the screen has a number of apertures positioned radially of the bottle being inspected, these apertures being closer together in the region where smaller particles are likely to be found.

Fig. 7 shows an elevation of the machine, partly in section. A central shaft 1 carries a head 5 supporting four platforms 6 to receive the bottles. The bottles are fed to the platforms by a guide 8 just above a conveyor. Each platform has three small apertures placed on a radius from the center of the bottle toward the center of the machine. A lamp 10 is positioned above the bottle so that the light shines through the bottom, then through the apertures and to a set of three photo-cells, one opposite each aperture.

The head is driven through a friction clutch 22 from a motor 19. As the head rotates, each bottle comes into contact with a flexible belt 24 which causes the bottles to rotate on their vertical axes. Each photo-cell is connected to an amplifier inside a casing 27 which, in turn, is connected with a magnet 30. This connection is such that when the light through any of the apertures beneath the bottle decreases, the magnet 30 is de-energized, allowing a trip rod 31 to fall. This throws an ejector mechanism into operation so that the defective bottle is thrown out.

The plan view of this machine is, in general, about the same as Fig. 8 of the following abstract.

The following references are of record in the file of this patent: United States Patents: 2,100,227, Stoate et al., Nov. 23, 1937, and 2,265,037, Gulliksen, Dec. 2, 1941.

Inspection Apparatus for Milk Bottles. Fig. 8. Patent No. 2,454,412. This is another invention by Norman P. Stoate of London and is assigned to the same company as the above patent. The main object of this patent is to improve on the preceding patent to make a more delicate

(*Continued on page* 52)

CHEMICALS FOR THE GLASS INDUSTRY

Alumina Hydrate	Iron Oxides
Antimony Oxide	Lithium Carbonate
Antimony Sulphide	Lithium Fluoride
Arsenic	Manganese Oxide
Babosil	Neodymium Carbonate
Barium Carbonate	Neodymium Oxalate
Barium Selenite	Neodymium Oxide
Barytes	Neodymium Salts, Pow. Blue
Bone Ash	Nickel Oxides
Borax	Potassium Bichromate
Boric Acid	Potassium Carbonate
Cadmium Hydrate	Potassium Nitrate
Cadmium Sulphide	Potassium Permanganate
Cerium Hydrate	Potassium Silicofluoride
Cerium Oxide	Salt Cake
China Clay	Selenium
Chromium Oxide	Sodium Bichromate
Cobalt Oxide	Sodium Nitrate
Cobalt Oxide & Salts	Sodium Phosphates
Copper Oxide & Salts	Sodium Selenite
Copperas	Sodium Silicofluoride
Cryolite	Strontium Carbonate
Didymium Carbonate	Sulphur
Didymium Oxide	Tin Oxide
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Gold Resinate	Zinc Selenite

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INVENTIONS AND INVENTORS . . .

(*Continued from page* 50)

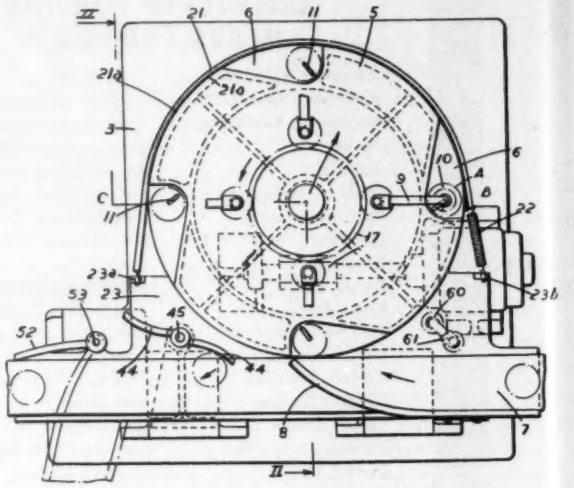

Fig. 8. Inspection Apparatus for Milk Bottles.

machine which will detect smaller particles of foreign matter in the bottle and to overcome the action caused by variations in the thickness of the bottom which cause variations in the amount of light transmitted.

Fig. 8 is a plan view of this machine and about the only noticeable difference from a similar view of the preceding patent is the substitution of a narrow slit 11 for the three holes shown in the other patent. In order to compensate for variations in the thickness and shape of the bottom of the bottle, the shape of the slit 11 may be changed or the passage of light may be varied toward and from the center of the bottle by additional apparatus. The general operation and construction of this machine is substantially like the companion patent described above.

The following references are of record in the file of this patent: United States Patents: 2,100,227, Stoate et al., Nov. 23, 1937, and 2,267,961, Tillyer et al., Dec. 30, 1941.

PEMCO COMPLETES NEW LABORATORIES

The Pemco Corporation has announced that their new $50,000 Research and Development Laboratory has been completed and is now in use by members of the staff conducting research and development work on the company's products.

The new laboratory which has been under construction for the past six months covers approximately 10,000 square feet of floor space and contains twelve completely equipped laboratories for various phases of research, a research library, staff offices and conference rooms.

Laboratories have been provided for greatly expanded research and development work in the fields of glass enamels and inorganic colors for all types of ceramic ware. Improved facilities for batch mixing, smelting and milling have been provided as have a new and complete equipped chemical laboratory and a complete physical properties laboratory.

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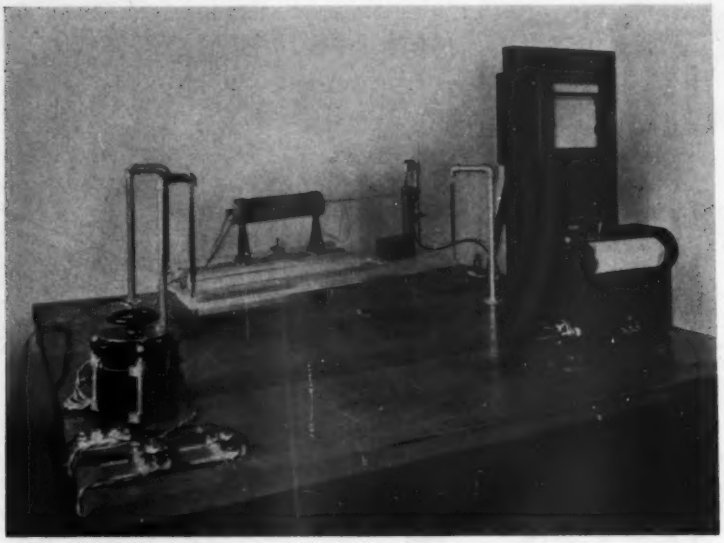

Apparatus for measuring thermal expansion of earth materials includes the latest type automatic control and recording equipment for maximum precision of temperature and expansion measurements. The small, cylindrical electric furnace enclosing quartz dilatometer tube and specimen, and the Baldwin Microformer extensometer unit are mounted on a spring suspended platform. The Microformer recorder is shown on the table and the Micromax temperature controller and recorder is behind it.

RENSSELAER POLYTECHNIC INSTITUTE RESEARCH PROGRAM

Fundamental data on the earth materials will be obtained over a period of years at Rensselaer Polytechnic Institute, according to the present plans of that Institute. The lack of needed fundamental thermal expansion data of highest accuracy on many earth materials has become of enough importance to justify a thorough research project. Such data are needed more and more in geophysical and mineralogical studies and will also be useful to industries that use and manufacture materials such as glass, tile, clay products, refractories, electrical insulators and resistors, etc.

Professors Joseph L. Rosenholts and Dudley T. Smith, who recently set up special testing equipment in the Department of Geology and Mineralogy at the Institute, have started on this project. Purchase of the necessary equipment was provided largely by Rennsselaer's Research Fund, but also by grants-in-aid from the Carnegie Corporation and the Research Corporation, both of New York.

The investigators will determine the linear thermal expansion of rocks and crystallographically oriented mineral specimens at temperatures ranging from 20 deg. C. to 1400 deg. C. Mineral transformation temperatures will also be determined. Specimens are ¼ in. square prisms ½ in. long which are prepared by saving mineral crystals parallel to their crystal axes. Diamond saws are used for most minerals. They are placed in the closed end of a 20 in. long quartz dilatometer tube. This end of the tube is in a small cylindrical electric furnace and the open end extends horizontally out of the furnace and into an Invar sleeve on a follower unit that was specially designed by the Testing Equipment Department of The Baldwin Locomotive Works.

The microscopic changes in length of the half-inch specimens with increasing temperature are measured by the Invar follower unit which incorporates a Microformer extensometer and recorder that were recently developed by The Baldwin Locomotive Works. The core of the Microformer extensometer is activated by an Invar lever which is in turn activated by a quartz rod extending through the quartz tube to the end of the specimen in the furnace.

Expansion of the specimen may be magnified up to approximately 2000 times by the Microformer Recorder which automatically draws a deformation-time curve on the recorder chart. This equipment incorporates a self-balancing transformer bridge which is sensitive to length changes of the order of two millionths of an inch.

DIFFRACTION EXPERTS LECTURE AT PHILIPS X-RAY SCHOOL

Guest lectures on X-ray diffraction, crystallography and spectrometry by internationally recognized authorities were featured at the annual Fall School in X-ray Diffraction and Spectrometry held by North American Philips Company, Inc.

The lecturers included Dr. Rudolph Brill, Philips Petroleum Company; Dr. Caroline MacGilavry, University of Amsterdam; Professor R. Pepinsky, Alabama Polytechnic Institute; Professor I. Fankuchen, Brooklyn Polytechnic Institute; Dr. Frank Chesley, Central Research Laboratories and Dr. William Parrish, Philips Laboratories, Inc.

SYLVANIA ELECTRIC OPENS NEW LIGHTING CENTER

In its new and completely remodeled Lighting Center, Sylvania Electric Products, Inc., illustrates how modern light techniques applied with ingenuity and practicability can transform a dingy 30-year old house into an up-to-date home.

Incorporating more than twenty ideas for utilizing light to best advantage in the home, the new rooms, which were built in cooperation with Lurelle Guild, illustrate how both fluorescent and incandescent lighting can be used decoratively to illuminate a wide variety of seeing tasks. Solutions to lighting problems existing in every home are found at the Center.

AT FIBERGLAS ITS FELLOWSHIP . . .

(*Continued from page* 26)

plant by the president and by W. R. Zimmerman, executive vice president; Games Slayter, vice president in charge of research and development; Harry R. Winkle, vice president, treasurer and comptroller; Ben E. Boyd, vice president in charge of manufacturing; and General Personnel Director O'Neill.

These are but a few highlighted functions of the Owens-Corning Fiberglas Corporation's personnel framework. Perhaps none of them is unique. The total combination, however, is far from common.

To weigh the components of the program as to relative importance would be difficult, but it is reasonable to place the Fiberglas Clubs and their carefully framed methods for inspiring initiative from the ranks of the employees themselves among the main keys to the effectiveness of the whole effort.

The plant personnel directors—C. R. Westcott at Ashton, D. E. Shafer at Newark, A. B. Walton at Huntingdon and O. M. Eclebery at Kansas City—feel sure the Fiberglas clubs and their democratic ways play an important part in building the *esprit de corps* which is so necessary to the continued success of any organization. Recreational authorities confirm the feeling of these men.

Of the Ashton facilities, Jack Cronin, coach of the perennially successful La Salle Academy football team and Director of Recreation for the city of Providence, says, "I have never seen such a wonderful set-up to aid the employees in their recreational program. Fiberglas is a pace-setter in this field."

The Ashton Fiberglas people made up a club which has always had a certain intangible individuality, but now they are doubly set apart through this material possession just as the Newark people are known for their Fiberglas Field, scene of a mammoth annual picnic and used daily as a sports park.

Specific points to evidence the value of the Fiberglas Clubs are difficult to tie down, according to Mr. Westcott. "Morale is an intangible thing," he says. "It simply can't be measured in dollars and cents. There is a great deal more to any job than wages, hours and working conditions. An industrial recreational program, which provides social, athletic and welfare activities has a two-fold purpose. It helps round out a person's life and in turn makes him better equipped, psychologically and physically, to perform his daily tasks.

"We have a reputation in this area for being honest and fair with our people and we intend to keep that reputation. People like to work at Fiberglas as is evidenced by the fact that 70 per cent of those presently employed at Ashton have been with us more than five years."

If the credo of employee contentment means providing the facilities, Fiberglas has done it convincingly at Ashton—and neither the recreational area nor the production set-up is up for sale.

• The Thirty-Third Annual (1948-49) edition of the Chemical Engineering Catalog has been published, according to a release from the publishers.

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By order of the United States District Court for the Northern District of Ohio, Western Division, Owens-Illinois Glass Company offers for sale as a unit all real estate, buildings, machinery, production equipment (not including molds), tanks and furnaces (except experimental machinery and furnaces) located at Chicago Heights, Illinois, and which were a part of the assets acquired by Owens-Illinois Glass Company from Kimble Glass Company on July 1, 1946.

In accordance with the order of the Court such property is offered for sale for cash to any purchaser approved by said Court, subject to prior sale, at the fair market value of said property as a glassware manufacturing plant, as determined by an appraisal made by The Lloyd-Thomas Company, which said appraisal has been duly filed with the Clerk of said Court at Toledo, Ohio., where it may be inspected. Additions and improvements made to the property described above since July 1, 1946, and prior to consummation of sale are not included in the appraised value aforesaid but are offered for sale as a part of the unit for an additional consideration equal to the cost thereof to Owens-Illinois Glass Company.

In connection with the sale of the property and additions and improvements thereto above described, Owens-Illinois Glass Company will assign or cause to be assigned to the purchaser thereof for the consideration hereinafter set forth, all its rights in and to the following machinery and equipment leased from Hartford-Empire Company situate on said premises on July 1, 1946, to-wit:

4—4 head I S machines with feeders, revolving tube drives and motors, and variable speed drives and motors

1—5 head I S machine with same

2—36" x 74' lehrs, gas fired with top vertical discharge, motor driven steel plate exhaust fan, and all regular equipment

The consideration to be paid by the purchaser to Owens-Illinois Glass Company for the assignment of its rights in the leased machinery aforesaid shall be cash in such an amount as will reimburse Owens-Illinois Glass Company for a fair proportion of any and all payments made in connection with said leased machinery by Kimble Glass Company or Owens-Illinois Glass Company which may be considered as costs of installation, advance payments for minimum annual royalties, license fees, parts, insurance and taxes.

In the event of such sale, possession will be delivered not later than six months after the consummation of such sale to a purchaser approved by the said Court.

Address all inquiries to

Owens-Illinois Glass Company
Attention: F. G. Morfoot
P. O. Box 1035, Toledo 1, Ohio

AN EMPIRICAL TREATMENT OF VISCOSITY DATA . . .

(*Continued from page* 20)

describing the fiber elongation equipment. The precision and accuracy are there shown to be within ± 1%. The precision of the calculated points from the $\sinh^{-1}$ curve depends upon the glass composition. In the normal range of container glass compositions such as reported by Robinson and Peterson, the variation from experimental values is at all times within 5% and often within 1%. As this method is to be used for quality control, however, it is not necessary that the calculated results agree exactly with absolute experimental results but rather that the results be consistent. Reproducibility of results on any given glass is within ± .3°C.

Application to Quality Control

Because of this excellent reproducibility, and the speed of the determination, this method is well suited for control purposes. It has been found that very minor changes in composition become apparent immediately as a change in, for example, the calculated softening point. A change in Na_2O of 1% will cause a change of 10°C. in the softening point, while the same change in CaO or Al_2O_3 content will change the softening point 8° and 5°C. respectively. In view of the fact that the softening point of a glass can be determined within ± .3°C., it is a very sensitive check on composition changes. It is not unusual to locate errors in batch mixing before the mistake has caused trouble in the tank. Viscosity determinations are especially informative during a formula change, as the variation in workability can be followed continuously throughout the change because of the short time required for the determination.

The excellent results which have been obtained from this method do not require a skilled technician. Ordinary, unskilled help can be trained in a few hours to make the measurement and calculations. Two operators are required to draw fibers to be used for the measurement. While it is convenient to have two operators also conducting the tests, one can handle such determinations with ease. For example, two people can prepare the fibers and determine the viscosity characteristics for eight to ten glasses a day. One operator can handle about four a day with help only during the actual drawing of the fibers from the sample melt.

Summary and Conclusions

An empirical method for treating experimental viscosity data has been shown to be valid for commercial soda-lime-alumina-silica glasses. This method is not applicable to lead, borate, or borosilicate glasses.

With this method, which consisting of a plot of $\sinh^{-1}$ log η vs. $\frac{1}{T}$ through the origin, one experimental point established by fiber elongation technique is generally sufficient to establish the viscosity-temperature characteristic of an average silicate glass within 5%. As viscosity is very sensitive to composition changes, knowledge of the viscosity characteristics of a glass is a very valuable contribution to methods of quality control.

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TENTH GLASS CONFERENCE . . .

(*Continued from page* 22)

On Friday afternoon, a rather interesting session was held on decorating. Mr. Carl Uhrmann, of the Imperial Glass Company, presented decorating from the standpoint of the quality handware producers, whereas Mr. V. H. Remington, of B. F. Drakenfeld & Co., presented a practical discussion of the commercial decoration of machine-made ware. Excellent samples were made available by both of the speakers and they covered their subject thoroughly and in an interesting fashion. Various methods of decorating, or making artistic ware, described by Mr. Uhrmann, included the actual design of the piece, the etching, sandblasting, cutting and engraving. Mr. Remington indicated that all of the beverage containers are decorated by a wire-screen process whereas tumblers and cheese containers are decorated by the silk-screen process. The use of decals for glass decorations is not suitable apparently for anything but opaque-type ware and, therefore, does not find too wide an application. It was of interest to note that the trend in decorating is back to a simplicity in number of colors rather than to multiple colors as has been used in the past. The use of three-color decorations, especially in semiautomatic operations, apparently makes the decorating process costly owing to the large number of misprints caused and the fact that some of these may occur after two colors already have been applied.

TWO GLASSMEN DIE

The deaths of R. C. Fenton and August Weber have been made known. Mr. Fenton, Vice President of Fenton Art Glass Company, was for many years associated with his brother in this business until the latter's death a short time ago.

Mr. Weber, for many years Factory Manager of the West Virginia Glass Specialty Company, was the victim of a heart attack. He had been connected with the West Virginia Glass Specialty Company since its inception.

ELECTION OF OFFICERS AT KIRK & BLUM

The Kirk & Blum Manufacturing Company has announced the election of new officers made necessary following the death of its President, R. J. Blum.

Officers are R. J. Blum, Jr., President; C. F. Wulff, Vice President; W. R. Meuttman, Vice President; E. A. Vogel, Secretary; F. A. Zink, Director; O. F. Tenoever, Treasurer; and F. G. Weber, Assistant Secretary Treasurer. The Board of Directors includes in addition to the above officers, Mrs. S. W. Kirk and Mrs. R. J. Blum.

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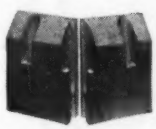

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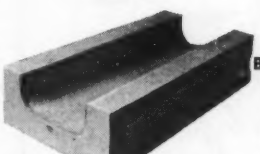

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RESEARCH DIGEST . . .

(*Continued from page* 41)

ultraviolet radiation without resort to opaque types of protection. Historical documents, rare tapestries, wearing apparel and book bindings are some of the materials in this category.

Ctyroky (*Journal of the Society of Glass Technology*, February, 1948) describes a series of experiments, the purpose of which was to develop such a glass. These experiments were made with glasses based on a parent soda-potash-lime-silica glass to which the elements chromium, titanium, cerium and vanadium and combinations of cerium and vanadium and of cerium and cobalt were added in various quantities. The spectral absorption of these glasses was measured and the following calculations were made: the coefficient of light transmission; the transmission after correction for reflection; the extinction coefficient for 10mm. thickness and for 3mm. thickness and the light transmission coefficient for glass 3 mm. thick. These spectrographic measurements showed that cerium and vanadium, or cerium and cobalt, gave the most suitable combinations.

The color of the glasses containing cerium and vanadium is greenish-yellow, but this shade is not so striking as the green color due to vanadium alone. The glasses containing the elements in combination best absorb ultraviolet radiation. The combination of cerium and cobalt gives practically colorless glasses, or with only a light-bluish shade. Using cerium and vanadium in combination, the best results are obtained if 1.9-6.5 per cent Ce_2O_3 and 0.5-2 per cent V_2O_5 are present. Using cerium and cobalt, the best results are obtainable if the

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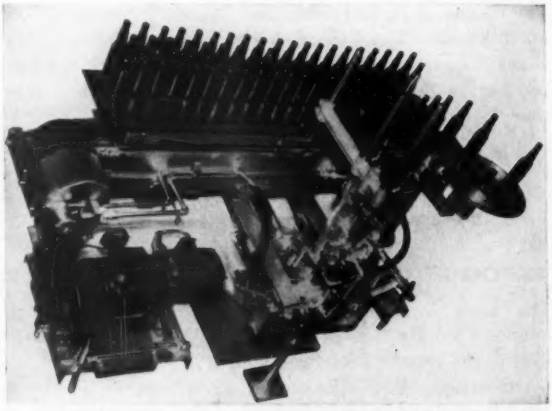

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glass contains 2-3 per cent Ce_2O_3 and 0.01-0.02 per cent Co_2O_3. In a thickness of 3 mm., these glasses are practically colorless.

A series of cerium and cobalt containing glasses was then made and their visible color and ultraviolet cut-off measured. From the data obtained, a glass was evolved in which the composition was derived from the following batch: 704.0 sand, 240.0 limestone, 300.0 sodium carbonate (15 per cent H_2O), 0.05 CoO, 19.5 CeO_2. This glass, in 8mm. thickness, is colorless or has only a fine grey tint and has a transmission of 0.89 per cent at 3690A.

These various glasses (Ce-Co series) were tested by an irradiation experiment using the light of a mercury vapor lamp and, alternately, sunlight. The following materials were used for testing: leather, dyed and undyed; silk dyed with various dyes; stockings, silk and artificial silk; and writing paper. Strips of the materials mentioned, partially covered by black paper, were exposed to the light transmitted by the glasses tested and the time necessary to cause the first visible color change was measured.

All of the special glasses melted showed good protective properties with the evolved glass possessing the best properties because while its protective power was not as high as some of the other glasses, it was practically colorless.

• Wheelco Instruments Company has announced the opening of a new district office at 2204 Fannin Street, Houston 5, Texas.

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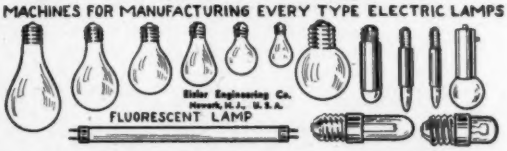

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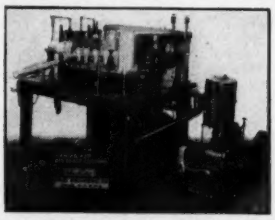

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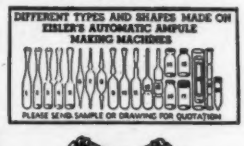
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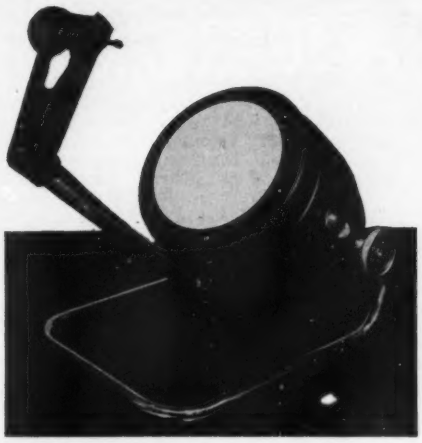

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PENNSYLVANIA CERAMICS ASSOCIATION ELECTS OFFICERS

The annual election of officers by the Board of Directors of the Pennsylvania Ceramics Association was recently held.

Officers elected for the fiscal year were President, W. L. Kenagy, Simonds Abrasive Company; Vice President, F. C. Flint, Hazel-Atlas Glass Company; Managing Director, E. C. Henry, Pennsylvania State College; Treasurer, J. R. Coxey, Pennsylvania State College; and Secretary, R. G. Ehman, Pennsylvania State College.

The Fourth Annual Spring Meeting of the Association will be held June 9, 10 and 11, 1949 at State College, Pa.

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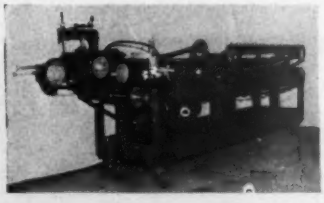

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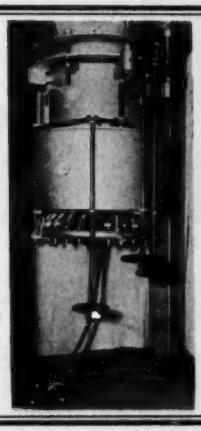
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